Aalborg University Copenhagen

Innovative Communication Technologies and Entrepreneurship

Internship project at YouSee A/S

Title: HbbTV- An Interactive Application

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                    Governance and Strategy

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Abstract:

This report is the result of the implementation of the HbbTV services. The identified services, according to the research, case studies and market analysis are VOD (Video On Demand), Weather, Highlights and Sports. These services are implemented according to the HbbTV specification version 1.1. The report describes Hybrid Broadband Broadcast TV in the light of HbbTV specification and its predecessors i.e. MHP and MHEG.

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ABBREVIATIONS

A/V	Audio/Video
AIT	Application Information Table
AJAX	Asynchronous JavaScript And XML
API	Application Programming Interface
ASI	Asynchronous Serial Interface
CE	Consumer electronics
CEA	Consumer Electronics Association
CE-HTML	Consumer electronics - Hypertext Markup Language
CSS	Cascading Style Sheets
DAE	Declarative Application Environment
DOM	Document Object Model
DRM	Digital Rights Management
DSM-CC	Digital Storage Media – Command and Control
DVB	Digital Video Broadcasting
EPG	Electronic Program Guide
ETSI	European Telecommunications Standards Institute
GUI	Graphical User Interface
HBBTV	Hybrid Broadcast Broadband Television
HD	High Definition
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IRT	Institut für Rundfunktechnik
JSON	JavaScript Object Notation
MP4	MP4 file format

NIT	Network Information Table
OIPF	Open IPTV Forum
OITF	Open IPTV Terminal Function
PAT	Program Association Table
PMT	Program Map Table
PSI	Program Specific Information
RTP	Real-time Transport Protocol
RTCP	Real-time Transport Control Protocol
RTSP	Real Time Streaming Protocol
SDT	Service Description Table
SI	Service Information
SSL	Secure Socket Layer
STB	Set-Top Box
TDT	Time and Date Table
VOD	Video on Demand
W3C	World Wide Web Consortium
XML	Extensible Markup Language

1. Introduction

1.1 Motivation and background

Last semester, we did an analysis-based project on Hybrid TV where the main focus was on: "What are the drivers and barriers for hybrid TV seen from technological, services, and market perspectives? The project area was very interesting and novel therefore, we wanted to continue working on it.

During the research phase of the project, we interviewed YouSee, which was very helpful and informative. It was very interesting to know that YouSee is working on Hybrid TV. We applied for internship to implement HbbTV services and make a business model. Fortunately, we got a positive response and the opportunity to work with YouSee.

YouSee A/S was formerly known as 'TDC Cable TV A/S that had been the distributor of analogue TV in Denmark for 30 years. The company was incorporated in 2000 and changed its name to YouSee in October 2007 to indicate a new digital age and establish a new name with their new digital product. YouSee is a subsidiary company of the Tele-Denmark Communications (TDC). In order to save a two-digit millions of rent, YouSee moved its location to the main offices of TDC in 2010.

YouSee is now considered as Denmark's largest distributor of TV and Internet solutions on the cable network and provides TV signals for approximately 45% [Profil.aspx , 2012] of all Danish households or around 1.2 million customers. Half of their customers are private customers, the other half are antenna and housing associations.

1.2 Problem formulation

HbbTV is a new concept in Europe and especially in Denmark where the Danish Radio (DR) is the only broadcaster who launched its HbbTV as a test pilot in March 2012. The limitations and challenges of HbbTV domain are not well known yet because of the novelty and limited implementation. Therefore, this will be the main issue in the HbbTV problem domain we will be dealing with while implementing the interactive services.

During the project process, we will focus on the following areas:

Easy user interaction

Naturally, we compare HbbTV service's layout and selection of a menu item with a web page and its point and click feature. One of the challenges is the remote control, which is not as user friendly as a mouse when it comes to the navigation between menus. Another challenge

is the limitations, which could be introduced by the HbbTV specifications, which is not mature yet.

Video

In PC world, normally the browser either has a player or a plug-in to play video. However, in HbbTV domain the challenge is how to control and use the video object in an easy and user-friendly way.

DRM

Which is the appropriate DRM for Pay-TV and VOD?

Market

What are the most attractive services for YouSee?

How could the developed service add value to YouSee's Business Model?

What are the potential regulatory issues and possible solutions?

1.3 Methodology

Choosing the appropriate methodology is the key for a successful project. By a successful project, the project should complete in due time with at least a tested and a working prototype. In the following lines, we will describe the Software process model, Research process model and group management model we have chosen.

Software process model

The model we see fit for our project is the incremental delivery which is an in between the waterfall and Evolutionary models. This model suggests that the system should be broken down into a series of increments. Each increment is then developed separately. The most important and the least important services are identified and then the increments are defined. In this project, we have identified four important services (VOD, Weather, Highlights, Sports). After the discussion with YouSee, we realised that VOD is the most important service.

The requirements for the VOD is defined and then developed. Each service of HbbTV application is a functional and testable unit by the user. The feedback from the user is used during the development of the next service. Each new service adds functionality to the system. The benefit of choosing this model is that if we go out of time we will still have a functional system.

Research Process model

To successfully handle this project, qualitative research method is used where information is gathered from the literatures through both primary (Interviews) and secondary research (where the information already exists in several different places like Internet, books, commercial market research organization, international journals etc.).

As a part of the methodologies, following steps are predicted:

1. Subject area and Problem definition
2. Initial studies through the use of various resources (gathering information)
3. Devise study literature framework (Main areas, directions that we will be working with)
4. Collect Data and prepare case studies (Collection of data through the use of various resources like books, websites, articles, relevant international journals, reviewing literatures from the courses)
5. Interviews with some stakeholders in the Danish market.
6. Data Analysis
7. Making Conclusion

Group management

We are a group of 3 students where the research topics about the project and the related documentation are divided among the members. Each member is responsible to research, gather relevant information and document his/her work. The results achieved by the members are discussed in the meetings. The meeting is used as a tool to harmonize our work and stick to the milestone plan.

For group management purpose, we used the following tools:

- A group contract was made and signed by each member [appendix 12.9].

- We discussed the projects progress regularly in our group meetings.

- We kept a log file of our project process [appendix 12.6].

- Milestone plan was used to keep track of our project progress

1.4   Milestone plan

We have made two milestone plans for this project in order to harmonize the two different parts, where for example, Padam and Homayoon started researching technological part while Nilma started researching for attractive services that could be beneficial for YouSee. The milestone plans can be found in [appendix 12.10].

1.5   Structure of the report

This report has two parts: application development and business development. The first part is done by Padam and Homayoon and the second part by Nilma. The details can be found in action item list [appendix 12.7].

The report continues as follows:

Technology section: This section presents three different standards for Hybrid TV focusing on the parts that enables the realization of a hybrid broadcast broadband solution, the Adaptive streaming and the DRM.

Services section: Some services that can potentially add value to the broadcast content are discussed here in terms of interactivity, personalization and convergence.

Market section: This section describes the potential penetration of the HbbTV in the market and what are the attractive services where we can propose business model for these services.

Analysis section: This section describes requirement specification, use cases, system design, implementation and testing.

Conclusion section: This section concludes the project.

2. YouSee A/S

In this section we will describe the company's services, turnovers, revenues and market shares.

2.1   Services

Through the cable network, the main services YouSee offers are TV, broadband services and telephony. With several TV solutions available YouSee's "full package" has 35 channels, and if the customer orders a digital set-top box with their subscription, called a Selector, they are able to receive more channels. YouSee 's Internet, formerly known as Web-Speed[1], comes in several solutions of up to 50 Mbit downstream and 4 Mbit upstream and includes a web-space with tools to create your own homepage.

They use the DVB-C (Digital Video Broadcasting - Cable) standard for the distribution of the TV and broadband on the cable television.

The products that YouSee deliver are listed below:

- 170 TV channels.
- TV channels in more than 20 languages.

- 20 Radio channels from Denmark and International.

- On Demand service with the ability to record, pause and rewind.

- 460,000 household of broadband

- 80,000 households of IP telephony

- 25 Danish national TV channels

2.2   Turnovers

YouSee A/S revenues was DKK 4,259[2] million in December compared with DKK 4,012 million for the same period a year ago, which means a rose by 415 million or 11.5%. The EBITDA (earnings before interest, taxes, depreciation, and amortization) of DKK 1,521 million compared with DKK 1,353 million for the same period a year ago, which means a rose of 18.6%. This was achieved by the increase number of the Revenue Generating Units (RGU) within all product groups (TV, Broadband and telephony) and increased the Average Revenue per User (ARPU). Despite an almost saturated TV market and strong competition in the broadband market, revenue in YouSee rose by 7.4% compared with 2010.

2.3   Revenues

In 2011, YouSee's revenues[3] increased by 6.2% compared with 2010. The raise in the revenues occurred even though there was a strong competition in the broadband market and almost saturation in the TV market.
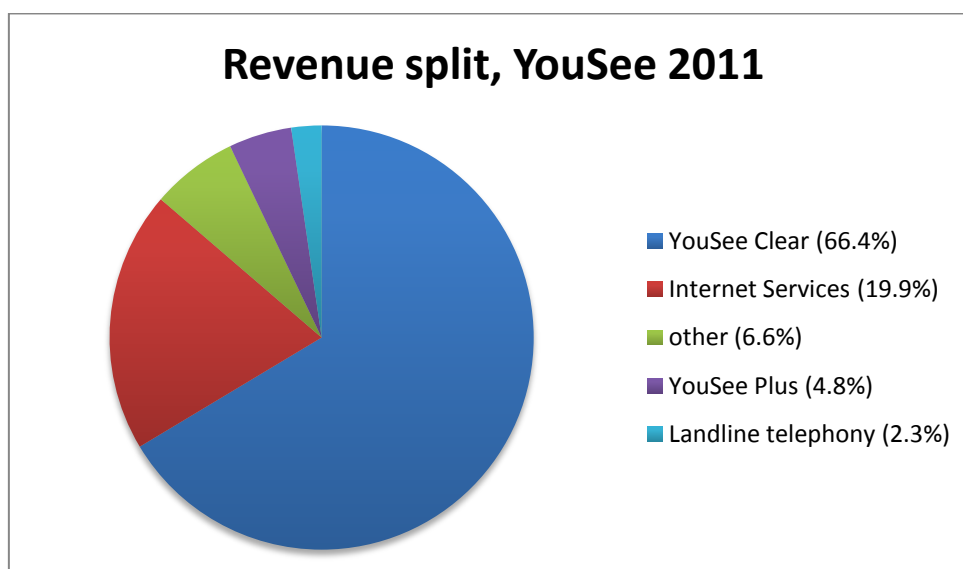
Figure 1: Revenue split, YouSee 2011

For YouSee, the year 2011 was a challenging year because of the strong competition from non-premium providers, adding to that the increase in the price sensitivity among customers.

Even though the subscription fees were raised which reflected a wide range of TV channels and increased the content cost, this had a limited affect on the customers and the ARPU (Average Revenue Per User) increased by 6.4%.

And there was a raise in YouSee Clear revenues by 6.9% compared with the previous year.

As for the YouSee Plus, the raise reached 10.2% compared with the previous year despite the raise in the copyright fees and the less expensive choice of TV packages from the customers.

YouSee gained the market share in 2011 for the Internet services because of the customer's demand for higher bandwidth. This demand had a positive effect on the revenues from the Internet services, which rose by 3.5%.

2.4   Market Share

YouSee is the largest cable-TV provider in the Danish market; it has a market share of approximately 58%[4] in Denmark. YouSee makes a great effort to achieve the delivery of the premium cable TV and a range of other products and services as well, such as the Internet. Its main product is 'YouSee Clear' that enables the customers to choose from standard digital TV packages or the 'Extra Channels'. The add-on products helped on increasing the market share for YouSee due to its flexibility and different features such as the start-over and pause. Nevertheless the video-on-demand feature that made YouSee get a market share of 49% of the Pay - TV market.

3. Technology

Before going into the depths of HbbTV, it will be worth knowing how its predecessors MHEG and MHP work.

MHEG and MHP lay a foundation for HbbTV therefore it has some similarities between them. But what differentiates HbbTV from its predecessors is that it puts the broadcasters in control so only they are able to relate broadband services to the broadcast program. The broadband contents in HbbTV are differentiated by broadcast related and broadcast independent applications. This relation is achieved through AIT. The details of AIT and the differences between broadcast related and broadcast independent application will be discussed later, but first some words about MHEG and MHP.

In the Television domain, the most interesting technological development is the interactivity. The interactivity is developed from the user being only able to zap between channels and Tele-text to broadband contents with rich graphics. **Interactivity** and **application signalling** are the important components of all the above three technologies, where each of them is implemented differently, which will be described individually for each technology.

3.1 MHEG

MHEG stands for the Multimedia Hypermedia Information Coding Expert Group and is an ISO standard published in 1997. The purpose of the standard was to define a method of storage, exchange and display of multimedia presentations[5]. MHEG was not dedicated to TV, but a more general platform that can be used in CD-ROM-based encyclopedia and interactive books for example.

Even if the standard consists of eight parts – MHEG-1 to MHEG-8, only the fifth part – MHEG-5 – is widely used (MHEG-6, MHEG-7 and MHEG-8 are considered as extensions to MHEG-5) in the interactive TV domain.

3.1.1 MHEG-5 Application signalling and Interactivity

Application Signalling

MHEG-5 applications and related data are loaded from the data carousel of the broadcast stream. To be able to run these applications, the receiver must know about their existence as well as how to manage them, this mechanism is referred to as Application Signalling. MHEG-5 leaves application signalling to specific profiles to specify it. The ETSI profile uses the PMT of the MPEG-2 TS and a Service Gateway object, acquired from the file system delivered by an object carousel, to implement it[6].

Interactivity

MHEG-5 Interaction Channel (MHEG-IC) enables connected TV to interact to broadcast services via an IP connection[7]. MHEG-IC is also adopted in the ETSI standard. MHEG-IC supports the standard protocols normally used to deliver the web content as TCP-IP and HTTP; and makes use of a special "web browser" to present HTML applications.

3.2 MHP

MHP, or the Multimedia Home Platform, is the collective name for a compatible set of middleware specifications [8] developed by the MHP group, a sub group of DVB, between 1997 and 2000.

The MHP standard defined these profiles:

1. Enhanced Broadcasting profile (Profile 1): The simplest version of an MHP environment supports this profile. It is aimed for STBs without a return channel in a low-cost area. In this case, applications may only be downloaded from the broadcast stream – the MPEG-2 TS. [9]

2. Interactive Broadcasting profile (Profile 2): Same as Profile 1 but includes support for a standardized return channel that allows an interaction between the audience and the broadcast.

3. Internet Access Profile (Profile 3): In this profile, Profile 2 is extended with support for Internet applications making it possible to combine Internet-based services, like email and web content, with the broadcast world.

4. IPTV profile (Profile 4): This profile integrates support for DVB-IPTV into MHP.

3.2.1 MHP Interactivity and Application signalling

MHP supports many communication protocols; some are TV specific as DVB-SI, DSM-CC and MPEG-2-TS, while others are network protocols such as IP, TCP, UDP and HTTP. The main way to get broadcast-related applications remains the DSM-CC object carousel, as the return channel is not mandatory for all MHP profiles. In absence of a return channel only light interactive applications and services can be carried in the broadcast stream e.g. teletext and EPG. Depending on the supported MHP profile, services may range from simple interactivity (as voting in a live program) via the return channel (Profile 2) to online games (Profile 3) and cutch-up TV and VOD (Profile 4).

GEM (Globally Executable MHP) is a subset of MHP standard specifications that can be implemented in environments that do not use necessarily DVB standards for broadcast signaling as OCAP[10] in U.S and ARIB[11] in Japan (**Error! Reference source not found.**). This makes it also possible for the GEM platform to bring interactivity to applications that do not require broadcast signaling as for Blu-ray discs[12].

3.3 HbbTV

HbbTV (Hybrid Broadcast and Broadband TV) is specifically designed for the Hybrid TV by the HbbTV consortium and published by ETSI as ETSI TS 102 796 V1.1.1 in June 2010[13]. The technical specifications are developed by the joint effort of the following bodies.

- Joint Technical Committee (JTC)

- Broadcast of the European Broadcasting Union (EBU)

- Comité Européen de Normalisation ELECtrotechnique (CENELEC)

- European Telecommunications Standards Institute (ETSI).
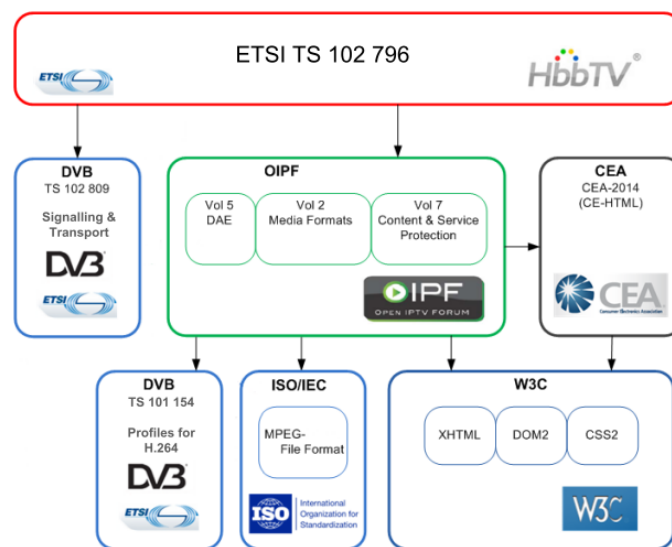
Figure 2: The Specification overview

HbbTV is not a totally new standard i.e. it is not started from scratch but references parts of already available standards and specifications and adapts the necessary parts of these standards. Following are some significant reference documents used in HbbTV.

- CEA-2014 - Web-based Protocol and Framework for Remote User Interface and the Internet (Web4CE), also known as CE-HTML.

- Open IPTV Application Environment of the Open IPTV Forum

- TS 102 809 (DVB) Signalling and carriage of interactive applications and services in Hybrid Broadcast Broadband environments

3.3.1   CEA-2014

Web-based Protocol and Framework for Remote User Interface on UPnP and the Internet (Web4CE) is published by Consumer Electronics Associations' R7 Home Network Committee. Currently there is no single standard that simultaneously insures home network device interoperability and a good user experience with the Internet services. CEA-2014 addresses these needs and is a framework for transmitting user interfaces over both the Internet and a home entertainment network. [14]

Web4CE (CEA-2014) has been accepted as the baseline remote user interface technology within the Digital Living Network Alliance (DLNA). Web4CE is the technology which can cross different domains like PC, mobile and TV in order to achieve: [15]

- Remote rendering of UI on other devices in the network

- For discovering client and servers in the network

- To exchange capability information between devices

The standard allows the UPnP Home network devices to present its interface as a web page, which can be displayed on any other device connected to the home network. The standard provides a browser based communication method for devices on UPnP network, which will allow users to control their CE devices using Ethernet and a special version of HTML called CE-HTML.

CE-HTML is one of the features of the Web4CE specially designed for television sets to allow user interaction take place using a remote control, keypad or a touch screen. Furthermore CE-HTML is optimized for rendering HTML/JavaScript web pages on CE devices, specifically on TV screens and scaling the contents for optimal use of the display area.

The collections of technologies used in CE-HTML are: [16]

- Definition of the application language (XHTML, CSS and JavaScript including AJAX).

- Definition of embedding non-linear A/V Content in an application.

- Definition of DOM event-handling (e.g. key events).

- Specification of still image formats.

Following is an example of a typical CE-HTML.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"ce-html-1.0-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>CE-HTML</title>
```

```
</head>
<body onload="document.getElementById('video_id').play(1);">
CE-HTML a/v object:<br/>
<object   type="video/mp4"   id="video_id"   data="myvideo.mp4"   width="640"
height="480"></object>
</body>
</html>
```

CE-HTML cannot convey interfaces to the "DVB world", shortcomings like this are provided by the browser specifications of Open IPTV Forum, specifically the DAE part.

3.3.2   DAE

Open IPTV is a Global organization containing representatives from all key stake-holders in the IPTV area like network providers, CE/Home/Mobile device manufactures, Network Infrastructure providers, Content & Service providers and Technology providers.

The Open IPTV Forum has developed an end-to-end solution that allows consumer devices to access enriched and personalized IPTV services. The OITF block of this solution resides inside the residential network. OITF has the functionality to access IPTV services from both the managed and the unmanaged network. One of the functionalities is the Declarative Application Environment (DAE), which is a browser based declarative language, based on CEA-2014 (CEA-2014-A). The DAE is for the presentation of user interfaces and also includes scripting support for the interaction with server-side applications and access to the APIs of the other OITF functions.   It provides functionalities such as personalization, seamless experience across Devices and Red button functionality. Red button on the remote control is one of the means of accessing broadcast-related applications.[17]

CEA-2014 is profiled through the OIPF DAE specification and the Open IPTV Forum Release 1 Volume 5 - Declarative Application Environment.

3.3.3   DVB (TS 102 809)

TS 102 809 is a Technical specification of a framework for signalling and carriage of interactive applications and services in Hybrid Broadcast Broadband environments. This specification covers.[18]

- Starting and stopping of applications, which are bound to broadcast, service, bound to content on demand item or bound to a network operator.

- The Distribution of interactive applications files or services through broadcast or broadband networks

- Synchronisation of interactive applications or services to video or audio contents distributed through broadcast or broadband networks

- Referencing video, audio or subtitle content from interactive applications or services distributed through broadcast or broadband networks

- Signalling interactive application and services

Important components provided by TS 102 809 for Hybrid TV are the application signalling and application transport via broadcast or broadband using HTTP. The signalling is done via AIT of the relevant DVB service as defined in MHP standard. The AIT carries the signalling of all applications, which are supposed to run in the context of the broadcasted program. If an application signalled in the AIT is marked AUTOSTART then the application will be automatically launched when the corresponding broadcast service is selected. More about this will be described in "Broadcast signalling".

3.3.4 Signalling interactive application and services

This component of the TS 102 809 is necessary for HbbTV because it helps the receiver to identify the applications associated with a service and find the location from which to retrieve them, the source of the broadcast data required by the broadcast-related application and how the signalling enables the broadcast to manage the lifecycle of applications. This is achieved by the following properties of applications.

Application metadata

Applications may have the following metadata associated with them.

Item	Description
Type	Identifies the platform needed to run or present the application.
Identifier	Identifies the application.
Control code	Defines the lifecycle state of the application.
Profile	Defines the minimum profile of terminal needed for this application
Visibility	Identifies whether the application is visible to the user or to other applications via an application listing API (where such an API is supported).
Priority	Defines the priority of the application relative to other signaled applications.
Icons	Identifies the location of icons for this application.
Graphics constraints	Identifies any constraints on this application with respect to changes in graphics configuration or presented video.
Storage information:	Defines whether an application should be stored, and which application files should be stored.

Figure 3: Application metadata.

Application type

A type is associated with each application, which is used by the terminal to discard unsupported applications.

In MPEG-2 encoding the application types are 15 bit numbers. The receivers use the type identifier to filter out signalling for unsupported application types and discard them. Application types are, for historical reason, registered with MHP_APPLICATION_TYPE_ID.

Application Identification

The item identifier in Table 4 is for the application identification. Each application is associated with an identifier. The application identifier consists of two parts, the organization_id and the application_id.

organization_id:

This field is a globally unique value that identifies the responsible organization for the application. This field is also used for authentication when X.509 certification is used.

application_id:

This field is allocated by the organization, which is registered with the organization_id field and is used to uniquely identify the application. [ETSI TS 102 809 Technical specification]

3.3.5   Applications lifecycle

Starting and stopping application may be initiated directly by the end user by using dedicated buttons on the remote control or from a menu provided by the application or in response to signalling in a broadcast service.

Broadcast signalling

The broadcast signalling is a mechanism, which enables the broadcasters to control the lifecycle of a standard application. This is achieved through the application control code, which is used by the broadcasters to signal to the receiver what to do with the application with regards to its lifecycle. A typical scenario could be when the user selects a broadcast service:

- The terminal shall determine if the service has signalled any application related to it.
- If the application is broadcast-related and is signalled with a control code of AUTOSTART and is not still running from a previously presented service shall be started.
- If it is already running, the service shall continue to run uninterrupted and a second instance of the application shall not be started.

- If it is signalled with a control code of PRESENT and it is already running then it should continue to run but shall not be started if it is not already running

- If an application is added to the service with a control code of AUTOSTART shall be automatically started when the terminal detects their addition.

- Applications added to the service with any other control code shall not be automatically started.

- If a service related applications control code changes from another value to AUTOSTART, it shall automatically start.

- Applications whose control code changes to KILL or DESTROY shall be stopped

- An application with DISSABLED control code shall not be started and attempt to start it shall fail.

3.3.6   AIT in HbbTV

The application control code is signalled through the application_control_code field in the AIT (Application Information Table). The AIT provides full information on the data broadcast and lists all broadcast related applications, the application_type, application_identifier, application_control_code and AIT version_number [Appendix 12.4]. The version_number is incremented by 1 whenever a change in the information carried within the sub_table occurs.

For each application in the AIT a descriptor loop gives all relevant parameters like organization_id, application_id and application_control_code etc.

3.3.7   Application transport

Via Object carousal

In ETSI TS 102 809 V1.1.1 (2010-01) transport of applications via DSM-CC object carousel is defined in section 7.1and is based on the following specifications.

- ISO/IEC 13818-1 - MPEG 2 systems.

- ISO/IEC 13818-6 - DSM-CC.

- EN 301 192 - DVB specification for data broadcasting.

- TR 101 202 - Implementation Guidelines for Data broadcasting.

For the HBB devices, which are not connected to the Internet ETSI TS 102 809, specifies the carriage of HbbTV applications via the DVB broadcast channel. The DSM_CC object carousel is used to transmit applications, similar to MHP, for such devices. Stream events in a DSM-

CC system consist of small data packets, which can be transmitted synchronously with the program signal.

The amount of data that can be distributed via broadcast channel is very limited as compared to broadband but could be sufficient for lightweight information application. These applications could be for example teletext services.

Via HTTP

"When applications are downloaded using the HTTP protocol, the HTTP 1.1 protocol shall be supported as defined in RFC 2616." [HbbTV Specification 1.1]

3.3.8   Security

Section 11 of the HbbTV specification defines two levels, trusted and not-trusted, for applications. Broadcast related applications are trusted by default while broadcast-independent applications are not trusted. However the specification further specifies that the default behaviour may be modified as follows:

- Terminals may include a mechanism such that the end user is able to configure the broadcast-related application from a particular channel as non-trusted or the broadcast independent application as trusted.

- Applications from non-regulated channels, such as satellite channels, should not automatically be trusted. For example adult applications from Hybrid broadband broadcast satellite channels except following explicit end-user approval should not be trusted.

- Thawte and VeriSign TLS and SSL Root Certificates are supported.

- In HTTP over TLS, a client certificate is needed when it is required that Hybrid broadband broadcast application is delivered to the trusted terminal.

3.3.9   *Hybrid terminal*

A hybrid terminal is composed of the following functional components:
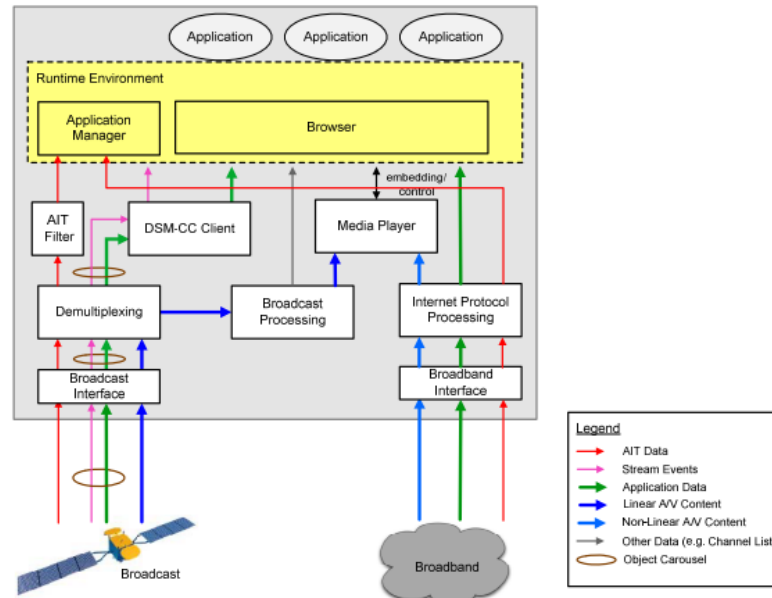
Figure 4: Structure of a hybrid terminal.

- Runtime Environment: Interactive application is presented and executed in the Runtime Environment inside the Browser.

- Application Manager evaluates the AIT to control the lifecycle for an interactive application. It is also responsible for controlling visibility of an application, access to private data of an application, starting and stopping of applications

- DSM-CC Client recovers the data from the object carousel and provides them to the Runtime Environment.

- Broadcast Processing Processes Linear A/V content en the same way as non-hybrid DVB terminal. Some information and functions such as channel list information and tuning functions are accessed by the runtime environment. These are included in the Other Data in the figure.

- Media Player is used for scaling and embedding linear and Non-linear A/V content in the user interface.

- Broadband Interface: The terminal connects to the Internet via this interface. This is the return channel of the Hybrid TV, which is used to request application data from the servers of an application provider. This connection is also used for Non-linear content like for content on demand applications.

- Internet Protocol Processing has the functionality to handle the data coming from the Internet and provide the application data to the Runtime Environment. This component forwards the Non-linear A/V content to the Media Player, which in turn can be controlled by the Runtime Environment, and therefore it can be imbedded into the user interface provided by an application.

3.4 Adaptive Streaming

Adaptive streaming is a technology that enables high-quality audio-video streams over the Internet dynamically. In the past, most of the video streaming technologies used streaming protocol such as RTP, RTSP. Today, adaptive streaming of major players is mostly based on HTTP such as Apple HTTP live streaming (HLS), Google WebM, Microsoft smooth streaming, Adobe's HTTP dynamic streaming, MPEG-DASH etc. Using HTTP has some benefits: it makes easier to get them through most firewalls of client machine, it has caching functionality that reduces loads on web services and increases performance.

HbbTV 1.5 specification was released on the 4th April 2012, which supports for HTTP adaptive streaming based on the recently published MPEG-DASH specification (Feb 2011) and it also enables content providers to protect DASH delivered content with potentially multiple DRM technologies based on the MPEG CENC specification[19].

3.4.1   MPEG-DASH

The first DASH (Dynamic Adaptive Streaming over HTTP) draft specification was published in February 2011. As the name says, it's a standard for adaptive streaming over HTTP that has potential to replace exiting proprietary technologies (HLS, Adobe Dynamic Streaming and Microsoft Smooth Steaming)[20].
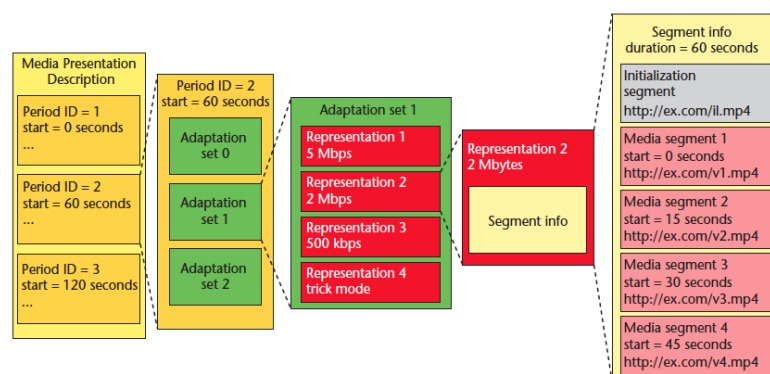
Figure 5: DASH Media presentation model[21]

DASH consists of two components: Media Presentation and Media Presentation Description. The actual AV streams are called Media Presentation. It is a collection of structured AV content that includes periods, adaptation sets, representation, and segments. It consists of one or multiple periods, where each period has a starting time and duration and consists of one or multiple adaptation sets. An adaptation set contains the information about one or multiple media components and its various encoded alternatives. For example, different bit rates of the video component of the same multimedia content or audio component. Each adaptive set can use one or multiple DRM scheme as long as the client recognizes at least one. It uses the Common Encryption Scheme (CENC), which defines a signalling of a common encryption scheme of media content.[22]

Each adaptation set contains multiple representation e.g. 640x480@500kbps, 640x480@250kbps.

And, each representation is divided into media segments, which are the media stream chunks in temporal sequence. Each segment has a URI.

The Media presentation Description (MPD) is an XML document that describes a manifest of the available content, its various alternatives, their URL address, and other characteristics and segments, which contain the actual multimedia bit streams in the form of chunks, in single or multiple files.
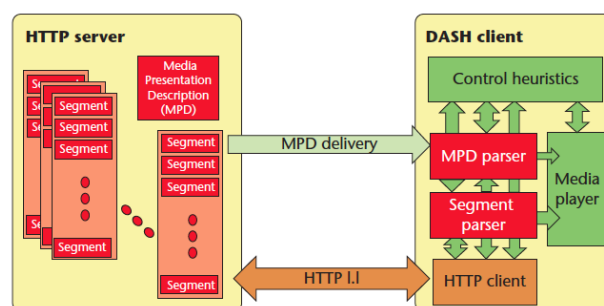
Figure 6: Streaming scenario between HTTP server and a DASH client

The client requires MPD to play the content. The MPD can be delivered to the client by using HTTP or email or any transport media. The client analyses the MPD about the program timing, media types, resolutions, minimum and maximum bandwidth, encoded alternatives, required DRM etc. Using this content's characteristics, the client chooses the appropriate encoded alternative and starts streaming by fetching the segments using HTTP GET request.

3.5   DRM

Digital Rights Management is a technology that enables content providers to distribute, promote and sell digital contents in a secure way. It is a subset of Enterprise Content and Collaboration Management (ECCM)[23].

It is a number of techniques for restricting the free transfer and free use of the digital content. The DRM controls the rights depending on user ID, Position and responsibilities. It was invented to reduce the redistribution or copying of the audio video files and prevent piracy.

Many online stores with adopted DRM have different schemes to limit, for example, the number of devices the content can be played and for VOD for example, the number of times it can be viewed.

Many different DRM brands are in the market. The major two brands are Apple's proprietary FairPlay and Microsoft's PlayReady; those two are commercial, but there are other open sources such as Open Mobile Alliance (OMA DRM) and OpenIPMP.

Some of these popular DRM's will be analysed in the following sub-chapter to find out which brand is mostly suitable for the HbbTV application.

3.5.1   Apple FairPlay DRM

Is an Apple Inc. proprietary, which is built onto QuikTime multimedia software and it only works with Apple's products and iTunes and allows the assets or content to be authorized for a maximum of five PC's, Tablet's or mobile devices, but on an unlimited amount of iPods. The FairPlay digitally encrypts Advanced Audio Coding (AAC) files and prevent from using those files on an unauthorized environment[24] and it limits the usage of the content to the Microsoft Windows and Macintosh Operating Systems i.e. media cannot be played on other OS's such as Linux[25].

The file format of Moving Pictures Experts Group (MPEG-4) choice is the QuickTime. The standard covers the entire media task and inherits the QuickTime's stability, extensibility and scalability.

The encryption scheme used by FairPlay is the AES algorithm, where the AAC data is encrypted with the AES key. This key is encrypted with the user key that is stored on the iTunes database, while the user key is encrypted with the system key. This encryption occurs while transferring from the server to the client.

3.5.2   Microsoft's PlayReady DRM

Is Microsoft's proprietary, it was released in 2008 and the Silverlight supports the content restricted with it. It is compatible with windows media DRM[26]. It works on many devices including the portable devices but not the Apple iPods. It can be used to play both the audio and the video. Its content licensing terms vary by provider.

The PlayReady is designed to enable consumer entertainment scenarios such as protection of many content types, make it easy to transfer content on many devices belonging to the same user[27].

The PlayReady is an independent platform and can be ported on any device even if the portable device doesn't use the Microsoft technology. But the PlayReady PC supports only some of Microsoft products such as Windows Vista SP1[28]. It supports many formats such as AAC, H.264 and MPEG-4[29].
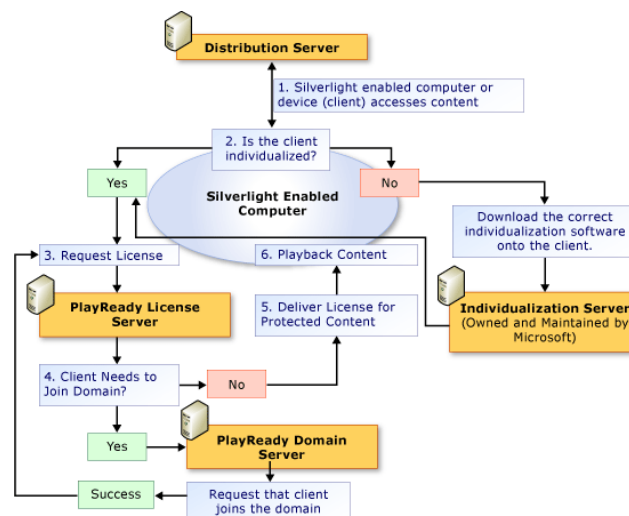
Figure 7: Microsoft PlayReady DRM[30]

The encryption scheme used by PlayReady is the AES[31] where the Silverlight application initiates the connection by sending a request to the distribution server. The client will receive an encrypted content. To decrypt the content, the user will receive a key from the license server. When the license server receives the request from the PlayReady for authentication, it will issue a license with the usage rights and restrictions, and then the client will be able to decrypt the content[32].

3.5.3   The open source OpenIPMP DRM

The OpenIPMP stands for Open Intellectual Property Management and Protection. It is an open source DRM for MPEG-4 and MPEG-2[33]. It aims to provide development group

interoperable DRM software that can be easily transferred to any platform such as Linux, Mac, windows and embedded platforms[34]. The interoperable solution that OpenIPMP provide adheres to many open standards including OMA (Open Mobile Alliance), MPEG-2 and MPEG-4. The Open IPMP includes J2EE (Java 2 Enterprise Edition) for issuing the licences and handling restrictions. The client SDK is intended for the integration with MPEG encoder and decoder, in other words the player.

The integration interface includes a pluggable key management, a crypto system interface and a client server protocol that uses web services such as SOAP.
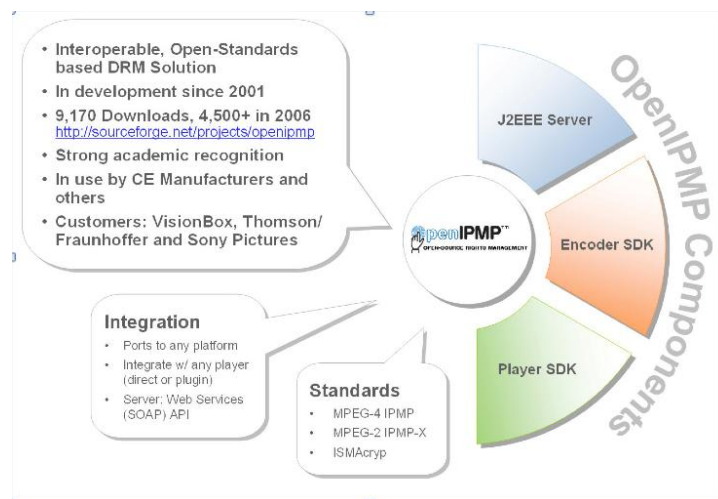
Figure 8: OpenIPMP DRM[35]

To secure the content and rights in a networked environment, the OpenIPMP uses the PKI (Public Key Infrastructure) with the encryption and the digital services. As for the certificates, it uses the X.509 certificate that forms the basis for digital identity on the Internet. To protect the licenses and other sensitive data that are intended for a particular user, the Open IPMP uses asymmetric encryption (RSA keys), while for the encryption of the media assets, it uses the symmetric encryption (Advanced Encryption Standard (AES) and Blowfish). The symmetric keys are used to encrypt media assets whereas the licenses of the

To verify the integrity of the critical systems objects such as licenses and content identifiers, the OpenIPMP uses the digital signature. Whereas for the critical transaction such as license acquisition and content registration, the Secure Sockets Layer (SSL) is used to ensure that information cannot be corrupted during transit.

3.5.4   Widevine DRM

The Widevine is a commercial solution for the DRM that provides solutions for the digital entertainment on any digital media devices. In 1999 Brian Baker founded Widevine and it

became a global provider for cable, Internet video services, etc. and in 2010 Google acquired it.

Widevine is widely used on Set-Top- Boxes [36](STB) and hundreds of service providers use its multiplatform DRM and video optimization for the security of audio and video.

It does support the Apple Mac and the Microsoft Windows platforms but not Linux[37] and as well as it supports many different devices. It is deployed on millions of devices including televisions.
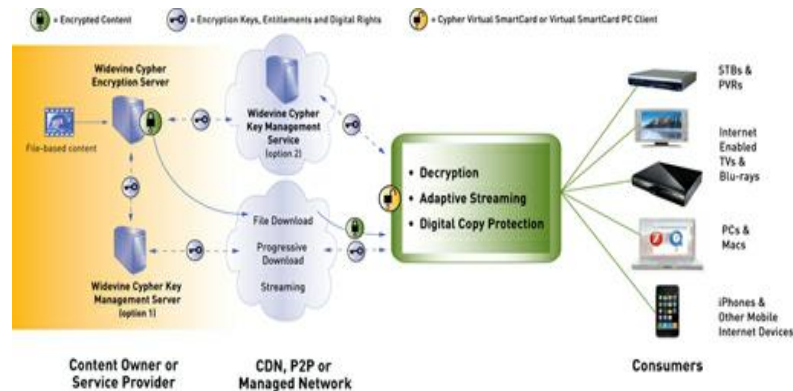
Figure 9: Widevine Architecture[38]

Since there are hundreds of the software tools that are available on the internet for the record of content and enable piracy, Widevine has added an additional level of protection to prevent those tools from piracy known as stream recorders and screen scarpers[39]. It works as follows:

- The content (video) is encrypted, stored and then distributed to the user
- The user uses a media player or the browser to watch the video
- During playback, the encrypted content is now decrypted and is now vulnerable for piracy
- The digital copy protection will detect this attack and produce a number of customizable responses from silent monitoring to revocation of viewing rights.

3.5.5   Marlin DRM

Sony, Philips, Panasonic, Samsung and Intertrust are the founders of Marlin DRM. In 2006 they launched an open standard community called Marlin Developer Community (MDC), and identified the trust management organisation[40]. The Marlin Trust Management Organisation (MTMO) is a neutral trust management-licensing organisation identified by the founders of Marlin. Since Marlin is an open standard, it relies on shared input from many interested parties to create an acceptable standard by all participants.

OMA is a complementary technology standard for Marlin DRM[41]. Marlin has applications in broadband, broadcast and IPTV market whereas OMA relates to the mobile market.

Other standard development organisations such as, OIPF (Open IPTV Forum) and Digital Entertainment Content Ecosystem (DECE) have adopted marlin specifications.

Many of the major studios such as, Warner Bros., Colombia Pictures and Walt Disney support Marlin DRM to protect their content for electronic sell of their digital assets, rental and subscription.
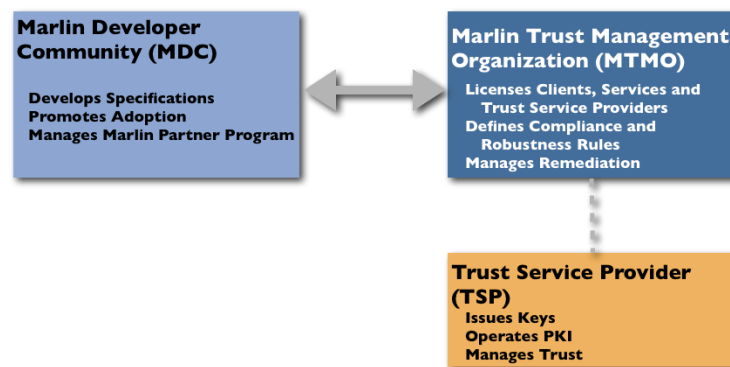
Figure 10: Functions and Roles of MDC and MTMO[42]

Main Specifications[43] of the Marlin DRM are listed below:

- Marlin Dynamic Media Zones Specifications provide support for the media content with specific attributes representing restrictions that the media player application must follow when replaying the content.

- *Marlin Core System Specification—Defines the basic components and protocols that form the basis of most Marlin implementations.*

- *Marlin Broadband Delivery System Specification—Defines additional capabilities that are unique to clients that can take advantage of an interactive IP-based communications channel. Among other items, includes protocols for obtaining licenses and reporting usage data for subscription-based services.*

- *OMArlin Specification—Specifies how to enable interoperable download, streaming, sharing and consumption of content between OMA and Marlin DRM systems.*

- *Marlin IPTV End-point Service Specification—Defines support for "end point" devices, such as TVs with IP capabilities.*

As for the media file format that the Marlin support:

- For Broadcast: MPEG2 TS PS

- For Mobile: a modified OMA DCF format

- For Broadband: any codec that can be transported in MP4 ISO

The Marlin BB[44] (broadband) was adopted by the OIPF as the essential content protection mechanism of the end-to-end specifications. It specifies the technologies for building DRM and copy protection into the end users devices and services.

In February 2012 announced Intertrust[45] its new version of Wasabi Marlin Client SDK that supports MPEG DASH. This new version is a complete Software Development Kit (SDK) for the development of the media applications based on Marlin DRM standard. It can be deployed on desktops (PC and Mac), Mobile (iOS and Android) and embedded systems with support for MPEG- DASH and common encryption on all platforms (Set-Top-Boxes and Connected TV). Gilles Boccon-Gibod, SVP, Technology and Chief Architect at Intertrust explained how the market of the connected TV and STB is highly fragmented and how each manufacturer is developing its own platform, then he said: "*With the release of the MPEG-DASH specification, there is now a common adaptive streaming technology for content publishers and broadcasters. The HbbTV 1.5 specification includes support for MPEG-DASH and a DRM. In France, the HD Forum, an industry group of broadcasters and CE manufacturers, has taken steps towards reducing the market fragmentation by developing a common platform built on the HbbTV 1.5 specification with support for Marlin DRM.*"

3.5.6   VCAS DRM

Verimatrix is a company specialized in securing the multi-screen digital TV services around the world. They have two winning award products, the Verimatrix Content Authority System (VCAS) and ViewRight[46]. Their aim is to help the pay- TV operators whom because of the convergence of broadcasting, broadband and mobile communication and that pay- Tv is no longer limited to the set-top-boxes, are getting more subscribers than expected for the Video on demand services. They have many customers globally, among those the Hollywood studios, when the cooperation started between them and the Federal Communications Commission to allow them to offer movies through pay- TV services. Verimatrix using the watermarking technology helped studios to combat piracy on streamed movies[47]. Whereas VCAS for IPTV is used by premier operators around the world such as SFR (France), Telia Sonera (Sweden), Etisalat (UAE) and many others. As for the VCAS for IPTV with DVB Hybrid support it is used by for example Telstra Clear (New Zealand), GTD (Chile), etc.

The VCAS3 are built on a common system core with modular extensions per segments where it implement a single authority for a multiple networks and devices. It supports a various video and DRM formats.

Because of the new opportunities that are rising due to the convergence of video services that are delivered on a managed and non- managed networks, VCAS3 provide the tools that work on multiple devices of all types[48]:

- *"Walled garden" IPTV and DVB over managed networks: telco, satellite, cable, terrestrial.*

- *Hybrid services, extending linear DVB services with IP-based VOD services and vice versa.*

- *Internet TV, OTT and mobile services implementing HTTP adaptive rate streaming.*

- *Harmonized rights management across multiple networks and devices.*

- *Wholesale-retail content distribution: a centralized, hosted service with local control options.*

- *Legacy CAS replacement with software-based security for all types of networks and devices.*

The VCAS 3 key components are listed below:

- Operator Management Interface (OMI): the administrative component for multiple Pay-TV networks for a single authority.

- Content Security Manager (CSM): to support authentication, key distribution and user control.

- Broadcast Content Security Manager (BCSM): for a one-way DVB network

- MultiRights: for a single authority using multi-networks

- Broadcast Encryption Manager (BEM) for the linear content encryption

- VOD Encryption Manager (VEM)
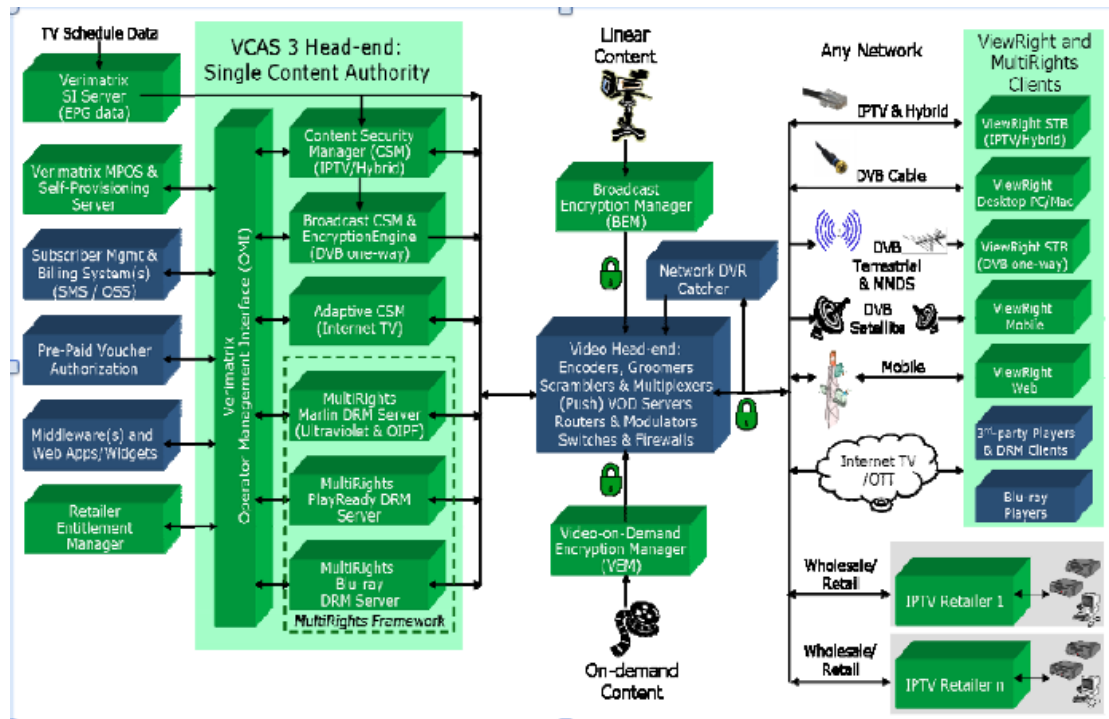
Figure 11: VCAS3 System Architecture[49]

Their software is built on proved cryptographic and secured transaction concepts that are used on e-commerce. They use for their security application:

- A two way standard based Internet security protocol.

- A public Key Infrastructure (PKI) public/ private key pair

- X.509 digital certificates

- AES-128 encryption algorithm

- The ViewRight that turns broadband connected PCs into interactive IPTV client.

VideoMark is the user specific legal watermarking with identifier that traces the last authorized recipient.
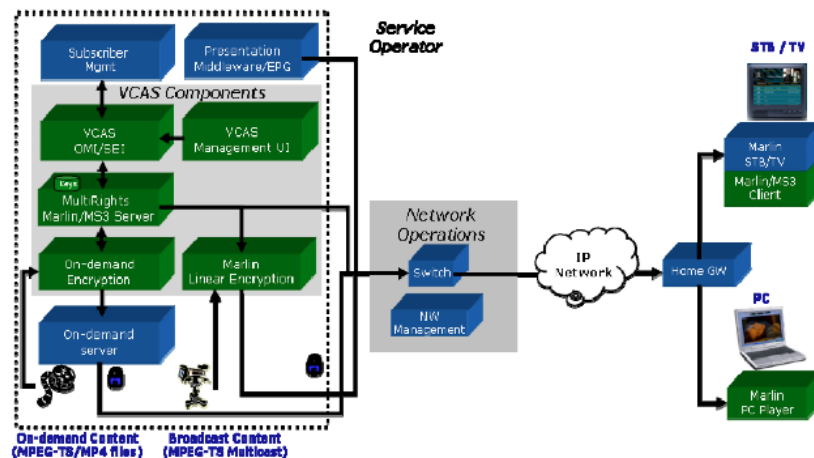
Figure 12: MultiRights for Marlin DRM – System Architecture

Verimatrix uses the Marlin DRM for the MultiRights within VCAS; they use a simplified set of the Marlin BB (explained in the Marlin DRM) in order to make a harmonization between the service operators and the service subscribers across a variety of devices. Along with this a usage of the MS3 (Marlin Simple Secure Streaming) key retrieval protocol is provided which offers lower complexity client support.

3.6   IRT broadcast server

IRT broadcast server is developed by Institut für Rundfunktechnik GmbH (IRT), the research center for the German broadcasters. The broadcast server permits to insert the necessary information in the broadcast signal for HbbTV applications. The server supports MPEG transport streams of the DVB standard family including IPTV. The compression methods, MPEG-2 or MPEG-4/AVC can be used to distribute both SDTV and HDTV. The server is also ideally suited for MHP applications and development testing. The server can be controlled through a GUI, for example if you want to change AIT table, PSI or input services etc. [appendix 12.4].

The output transport stream is provided through one of the following output devices

• Hard disk (integrated recording mode)

• ASI output cards as following:

> Computer Modules Master FD II (output and recording of input streams supported)
>
> Dektec DTA-series and DTU-series (output supported), including direct control for Dektec DTA-107 and DTA-110 QPSK and QAM-modulator boards (setting modulator parameters from the server user interface)

• UDP and RTP-streaming to an adjustable IP-Address: Port

The server configuration can be found in [appendix 12.3].

3.6.1 Key features

The broadcast server has the following key features:[50]

- Real-time multiplexing of multiple DVB transport streams containing SD/HD-TV
- Remapping and filtering of PIDs and services
- Recreation of PSI, user-configurable reassembly of components and services, generation of services,
- Creation of NIT/SDT/TDT
- Real-time DSMCC object carousel generator for HbbTV (or MHP)
- Simple configuration of module assignment and caching modes
- Support of multi-PID object carousels
- Live-update of whole carousels or modules
- AIT-Editor
- Multiple output options: DVB-ASI, UDP/IP, RTP/IP streams

3.6.2 System requirements

- Windows XP, 7, Server 2003, Server 2008
- Dual core processor, 2 GHz (x86-based)
- 2 GB RAM
- ASI or RF card. Supported are a selection of Dektec and Deltacast cards (please contact us for associated information)

3.7 ASI output cards

The broadcast server supports Dektec DTA-series and DTU-series. For this project, we used DTU-215.

3.7.1 Dektec DTU-215

It is USB-2 based multi-standard modulator, that supports QAM-, OFDM- and VSB based modulation standards. It doesn't need any external power adapter because it is powered from the USB-2 bus[51].

Figure 13: Dektec DTU-215

3.8 TV

HbbTV enabled Specifications

The display logical model for the HbbTV enabled devices has multiple graphics, subtitles, video and background colour[52]. According to Michael Probst (INSTITUT FUER RUNDFUNKTECHNIK GmbH / PD)[Appendix 1] "*The application shall be fullscreen with a logical resolution of 1280x720 which is no problem on 16by9 TV sets*".

	Value	Characteristic
Screen resolution	1 280 times 720 pixels with a 16:9 aspect ratio.	Static resolution.

Figure 14: Screen resolution[53]

The figure below shows the ordering of the logical planes.
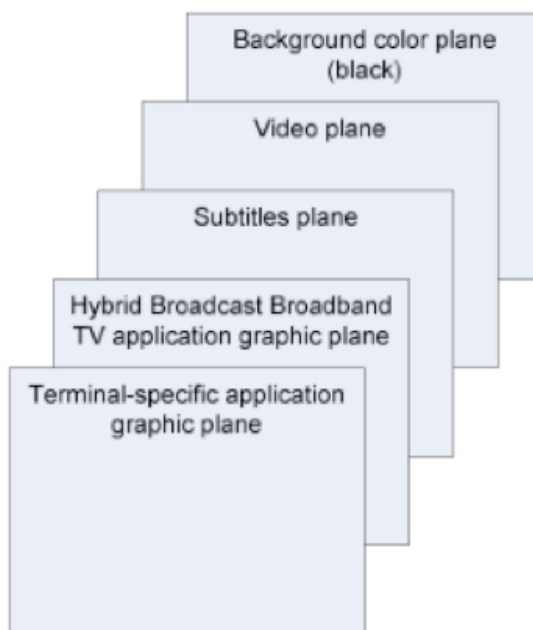
Figure 15: Logical plane model

The logical Planes requirements are as follows:

- The "Background colour": this plane shall only display a black colour. It lies at the bottom of the logical display stack.

- The "Video": this plane is used to display video. It lies on the top of the "Background colour" plane in the logical display stack.

- The "Subtitles": this plane is used to display subtitles and it shall lie on the top of the "Video" plane in the logical display stack.

- The "Hybrid Broadcast Broadband TV application graphic": this plane lies on the top of the "Subtitles" plane in the logical display stack and is used to display the Hybrid Broadcast and Broadband TV application. Its resolution is 1280x720 pixels.

- The "Terminal specific application graphic": this plane lies on the top of the Hybrid Broadcast and Broadband TV application and is used to display the terminal.

When the Hybrid Broadcast Broadband TV application is running which means that there is no video/ broadcast object is instantiated, the broadcast video will be under the control of the terminal.

The recommended safe area for the Hybrid Broadcast Broadband TV application is shown in the figure below:
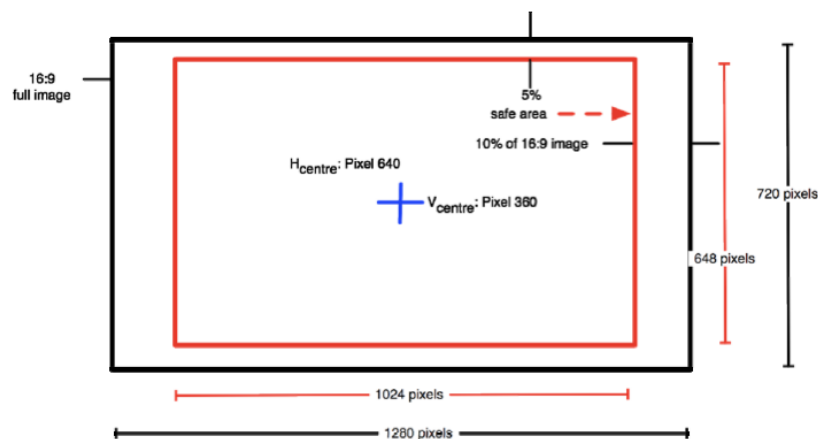
Figure 16: Graphic Safe Area

As for the browser, the *"HbbTV defines a browser profile based on CE-HTML. HbbTV profiles the DAE browser which profiles the CE-HTML browser"* [Appendix 1].

Whereas for the video/ audio requirements for the HbbTV are as follows [appendix- HbbTV A/V Profile]:

- The bitrate for the on-demand video/ audio stream is limited to 8 Mbit.

- HbbTV supports MPEG-4/ AVC and its profile is as follows:

- o The colour signal should be signalled in Voice–user interface (VUI)

- o The source aspect ratio must be 4:3 or 16:9

- o SD video shall use main profile and with luminance resolution of:

  - 720 x 576

  - 544 x 576

  - 480 x 576

  - 352 x 576

  - 352 x 288

- o HD video shall use High Profile and with luminance resolution of:

  - 1920 x 1080

  - 1440 x 1080

  - 1280 x 1080

  - 960 x 1080

  - 1280 x 720

  - 960 x 720

  - 640 x 720

- o For the interlaced and progressive format the frame rate is 25 Hz or 50 Hz for the HD video with progressive format, whereas the frame rates of 30 / 60 Hz are not supported

- AAC and Dolby are supported with the video

- Subtitles are optional unless the broadcaster is using the broadband video with TS, as container, then the HbbTV must support the same subtitling format as it does with the broadcast video. Whereas HbbTV does not support the MP4 format subtitles.

- ISO/MP4/AVC is supported by HbbTV

- MPEG-2 / DVB transport stream is supported by HbbTV

- HbbTV supports only http progressive streaming, but it is possible to provide services with the live content (linear).

  - o Only formats using transport stream are supported with the linear content

  - o The HTTP response body length is not known before the end of the connection, therefore HbbTV supports the following solutions:

    - Chunked transfer coding: is used when the length of the content is not known. In this case the HTTP header looks like:

- Transfer-Encoding: chunked
- Accept-Ranges: none
- Content-Type: video/mpeg
  - Simulating large file: in case where content length is needed: the HTTP header will look like:
    - Content-Length: 2147483647
    - Accept-Ranges: none
    - Content-Type: video/mpeg

The value of the above number (the largest signed integer for a 32 bits processors) is approximately sufficient for a 2 GB content size, which is around 2 hours of streaming at 2,38 Mbit/s.

3.9   Limitations

- HbbTV doesn't support formats other than MPEG 4.

- Future HbbTV 1.5 terminals will support DASH (specific profile of DASH). HbbTV does not support other streaming protocols. E.g.

  - Apple HLS

  - Google WebM

  - Microsoft smooth streaming

  - Adobe HTTP dynamic streaming

- HbbTV 1.1 does not support HTML5

- Limited   support   for   CSS   and   JavaScript(http://www.oipf.tv/docs/Release1/OIPF-T2-R1_DAE_Reference_Guide_v1_0-2010-03-11.pdf)

- CSS3 is not supported

- Aggregators will face legal issues if the Red Button is used and their universe will pop-up providing links to the different broadcaster's universes.

- Lack of the ability to navigate between the different channels for the broadcasters.

- The CE manufacturers do not put much emphasis in implementing the smart cards in the TV devices that is used by Pay- TV providers.

- RTSP is an optional part of HbbTV, which is not implemented at any HbbTV terminal yet

- VCAS DRM by Verimatrix is not supported yet

- According to the HbbTV 1.5 specifications, the following are issues with the DRM:

  - *An informative text is needed to identify how the key aspects of the DRM technology map on to the mechanisms and local interfaces*

- o *A DRM System ID for the DRM system needs to be registered.*

- o *If the DRM agent can generate user interfaces on the terminal then the interaction between these and the HbbTV system needs to be defined. This is particularly critical if these user interfaces are rendered using the same browser as is used for HbbTV applications.*

- o *Which combinations of protocols and codecs are required to be supported with the DRM technology need to be defined. These must be in the format of the video profile capability strings indicating.*

- With an e-mail interview with Klaus Merkel from IRT, he sent us the following limitations concerning the video / audio:

  - o *largesize and the co64 box defined in sections 4.2 and 8.19 of MPEG-4 ISO FF shall not be used*

  - o *The ftyp box shall be positioned before the moov box. The moov box shall be positioned before any mdat box.*

  - o *If fragmentation is used a moof shall be positioned before the corresponding mdat box.*

  - o *The size of the moov box shall not exceed 1 MByte.*

  - o *The size of a moof box shall not exceed 300 kByte*

  - o *Audio and video tracks shall be interleaved, where the length of a single chunk of a track shall not exceed 1 second*

  - o *Changes of errata #1 of TS102796 v1.1.1 to allow content with a larger length without using fragmentated mp4 files:*

    - ▪ *The size of the moov box shall not exceed 2.5MByte*
    - ▪ *Largesize as defined in 4.2 of MPEG-4 ISO FF may be used.*
    - ▪ *Explanation: Most encoders today do not support mp4 FF fragmentation and use largesize to define the size of the mdat box. Available HbbTV decoder support big moov boxes and largesize.*

4. Market

4.1 Potential HbbTV Market

Many opportunities are offered by the new smart TV sets, the purpose of HbbTV (Hybrid Broadcast Broadband) is to make TV shows available directly on the TV screen whenever the user has time by clicking on the red button and entering the broadcast portal.

Studies[54] about the Internet access and Internet access via the TV sets are made to show the global potential market of the connected devices. Below a graph that shows the Internet access globally that compares the Internet TV users to the overall market:
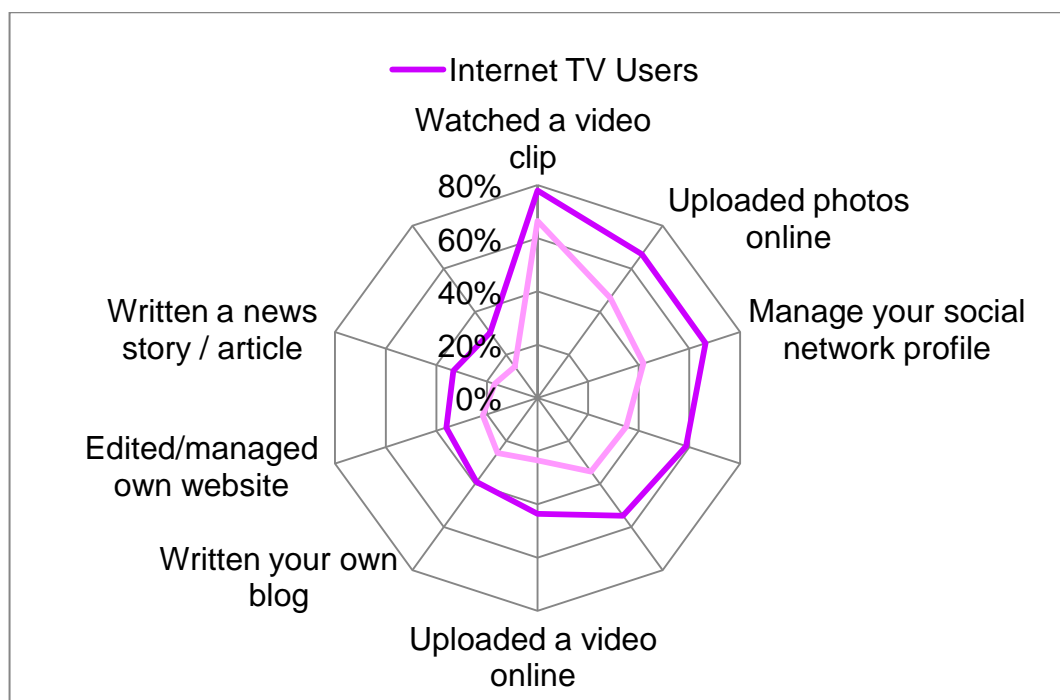
Figure 17: Internet users and their usage

Whereas the graph below shows the interest in future technologies regardless cost:
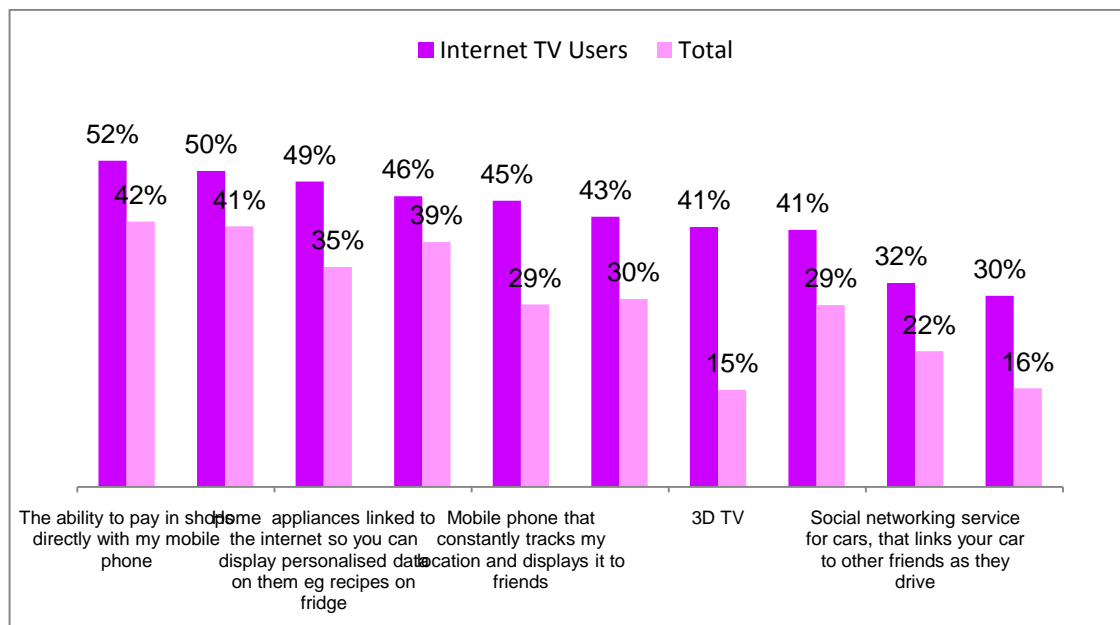
Figure 18: Internet TV Users

The social context that the on-screen apps provides, have a great affect on television advertisement. Ads are the main revenue sources for social networking such as Facebook and Twitter. Users using for example Facebook can chose to get ads from a commercial company by clicking on the 'Like' button to that company and they will start getting updates about their products.

Below is a chart to a survey made by GWI (Global Web Index), regarding the access of the Internet via the users TV set and the % is for each country. There were asked 3000 users in each of the mentioned countries in this survey.
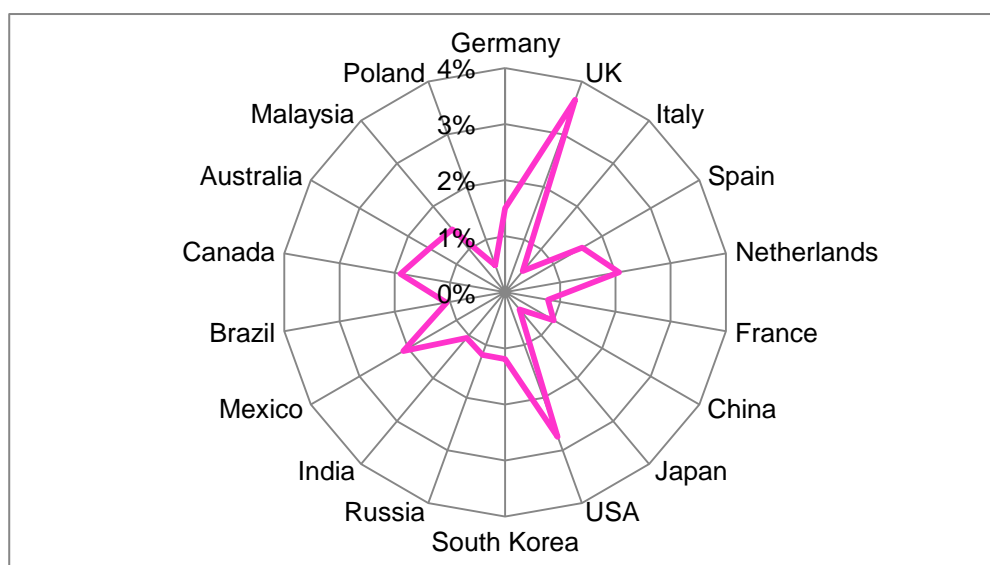
Figure 19: A survey about Internet Access via TV made by GWI wave 3 Data

The type of people accessing the Internet via the TV devices and their age plays a big role in the advertisement market and the HbbTV market in general. Below is a result of a survey made by the GWI group to identify the gender, the educational achievements and the ages of users using the HbbTV devices and accessing the Internet via the TV devices.
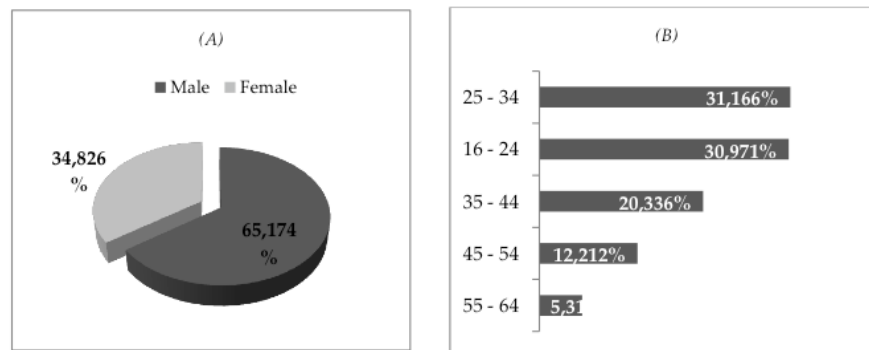
Figure 20: (A) Gender Breakdown. (B) Age Breakdown
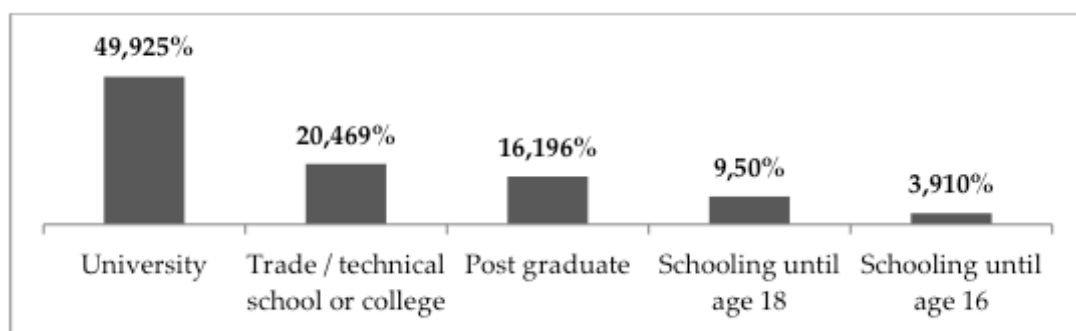
Figure 21: Education Breakdown

From the results above we can conclude that the users are mostly adult males with higher education. This type of users is more into using the social media to communicate with the world around them and generally they are interested in new technologies. Internet users are around four times to be early adapters for new technologies and they have the more positive outlook on the effect the Internet has on society

By Nordig applying the HbbTV specifications instead of the DVB MHP, this adoption increased the supporting nations by 6, which will contribute strength to the standard, because Nordig members include premium content players such as Canal+ and ViaSat.

As for the HbbTV enabled devices, a study made by IHS Screen Digest that expects a 132 million connectable TVs installed in Western Europe by 2015 where around 40 % of those will comprise HbbTV compliant TV sets[55]. There are also studies made in Germany predicting a market of 23 million HbbTV enabled devices by 2014[56]

According to a research made by AGF/GfK Fernsehforschung[57] says that an average of 18,700 German households switched to digital reception in November 2011. And that the total digital households reached to 19.96 millions which means that the speed of digitalization is accelerating. According to latest figures 55.7% which refers to 35.86 million households in Germany have at least one digital device such as iPTV. Another study was made also in Germany[58] that forecast a market of 23 million HbbTV enabled devices by the year 2014.

4.2   Case studies

4.2.1   ZDF case study

Zweites Deutshes Frensehen (Second German Television) is a public service broadcaster. It was founded in 1961 by the federal treaty, and launched for the first time in 1963 where in the same year it became a member of the European Broadcasting Union (EBU). It is an independent non-profit institute. It is financed by Television licence fees and advertising revenues[59].
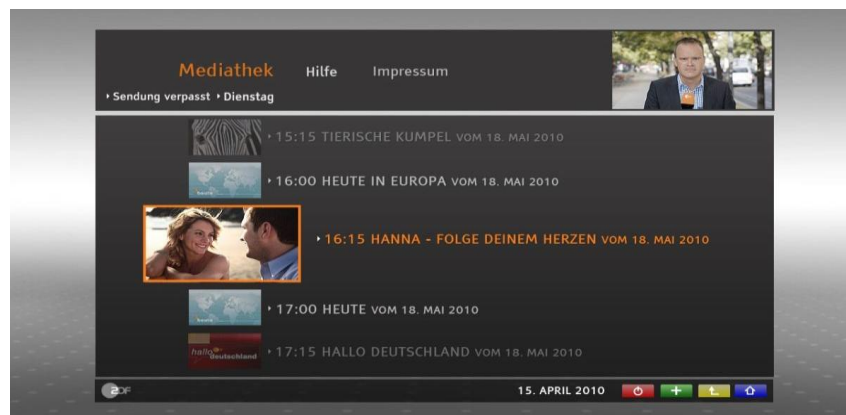
Figure 22: ZDF HbbTV Mediathek[60]

ZDF is a supporter of the HbbTV and they launched their HbbTV on DVB-T network in 2010. In October 2011 the public broadcaster ZDF reported its profits by €52.9 million and that their website attracts six million viewers a month[61]. The services used in the HbbTV application are:

1- Hilfe (Help)

2- Imperssom (Imprint)

3- Nachrichten (News)

4- Heute Journal Plus (News Plus)

5- Sendung verpasst (Catch-up TV)

6- Sendung A-Z (Program A-Z)

7- ZDF Mediathek (ZDF Media Center)

In the first half of 2011, the catch-up TV service Mediathek gained popularity with 30 millions views and the portal's mobile app that were launched on September 2011 were downloaded 390,000 times in one month.

Since the number of the ZDF users is increasing by up to 49% year on year where it reached in October 2010 close to six million[62], and in addition to its Mediathek, ZDF decided to make sports, news and weather programmes available through the HbbTV portal.

4.2.2   DR case study

Danish Radio (DR)[63] is the biggest Danish national broadcaster; it was founded in 1925 as a public-service organisation. It was founded in 1925 as a public service organisation. Nowadays it is considered to be Denmark's oldest and largest electronic media. In 1950 DR was on of the 23 broadcasters who founded the EBU (European Broadcast Union). DR began broadcasting in 1951. DR is funded by means of licence[64], it is set by the parliament and obliged when reaching the legal age, regardless of whether you make use of the DR's services or not. In 2007 the media license replaced the former TV license, the launch of the media license result in that everyone, who can receive DR's programs or services via TV, PC or mobile phones.

The table below shows the number of users[65] of DR.dk, and if we take into assumption that the dr.dk is the same as DR NU, we can say that there is a fairly steady evolution of 18% - 19% between the 2007 – 2011 years.

TABEL 7					
Brugere af DR					
PCT.	2007	2008	2009	2010	**2011**
Hele DR gns. ugentlig dækning[1]	98	98	98	98	**98**
DR TV gns. ugentlig dækning[2]	83	84	87	88	**88**
DR Radio gns. ugentlig dækning[3]	80	87	86	87	**86**
dr.dk gns. ugentlig dækning[4]	18	18	19	19	**19**

[1] Danskere i alderen 15+, kilde: Megafon Cati-undersøgelse.
[2] Danskere i alderen 3+, kilde: Gallup TV Meter, Definition: set min. 5 min. inden for en uge.
[3] Danskere i alderen 12+, kilde: Gallup Radio Meter, Definition: lyttet m. 5 min. inden for en uge.
[4] Alle danskere i alderen 7+, kilde: FDIM/Gemius (Forskudte kvartaler).

Figure 23: DR users

As a result of the launching of the media license, DR income increased as seen in the table below which means that the use of the DR NU is increasing:

DKK	2008	2009	2010
Media License	2,190	2,220	2,260
Radio	320	320	320
Business license	770	780	795

Figure 24: DR's License Fees per household[66]

According to Denmark's Statistics, the population of big cities such as Copenhagen will grow by 13%, whereas in the whole Denmark the growth will be expected to reach 3%[67]. The population in Denmark by July 2011 reached 5.529,88; among those 17.6% between the ages of 0-14 years, 65.3% between the ages of 15-64% and 17.1% for the ages of 65 years and above, which means a growth rate by 0.251%[68]. These results show that there is an increase of the populations, which means an increase of the viewers for the past years, and a potential increase of viewers until the year of 2020.

The above results encouraged DR to launch the HbbTV application on DVB-T network as a pilot test in March 2012 on its DR1.
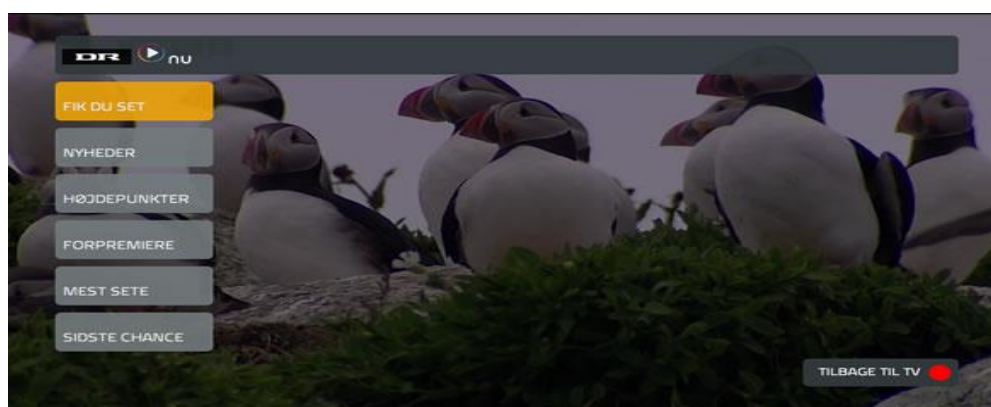
Figure 25: DR1 HbbTV application menu

DR have decided to observe the HbbTV application for errors, such as bugs that are making the system unstable, acceptance by the users, security issues and other considerations until the end of 2012 and then they will decide whether to keep the HbbTV application available for users using the HbbTV enabled devices or not.

They launched the application with 6 services listed below:

1 – News (Nyheder)

2 – Highlights (Højdepunkter)

3 – Previews (Forpremierer)

4 – Mostly viewed (Meste set)

5 – Last chance (Sidst chance)

6 - had you see (Fik du set)

The same above-mentioned services are used on DR NU the online service for DR; the only difference is that for the HbbTV application the services are available for only 7 days whereas on the web the services are available for a whole month. And since it is a test application they used the most used services available on DR NU.

4.3 Customer requirements

Understanding the customer's requirement of the specific market will make it easier for service providers to know how to market their product and who are their target groups.

Since the concerns for the market now are about the potentials for the HbbTV, then the need is to know, "what do customers want online?"

Two studies[69] highlighted this dilemma; Zatso made one and the other was made by Pew research centre.

Zatso's study " A view of the 21st century News consumer" observed people's reading habits. The study showed that 1 out of 3 respondent replied by that they use the Internet for checking the news, whereas almost 2 out of 3 of 3500f respondents replied by checking their e-mails and that emails gets them closer to their relatives and friends. This concludes that the most popular activity online is checking emails, and then the next best is reading news.

Pew study showed that those who are connected to the Internet have a better connection to their families and friends that those who are not.

Personalisation has its benefit on reflecting people's reactions where 75% of the respondent wanted on demand news and around 2 out of 3 wanted personalised news. Over the half of the respondents made educational research.

Other than email and news, 75% goes online to search for information about purchases they want to make. 64 % visited travel agencies webpages, 54% seek data about health and medicine, 38% seek job opportunities, 47% visit government webpages, 1 out of 3 played online games, 45% uses the Internet for instant messaging such as Messenger, Skype, etc. 12% traded stocks.

According to Levinson (the inventor of "Guerrilla Marketing") the most effective online sites are those who focus on providing the user with the information they want instead of focusing on entertainment. For him, *"Straightforward data, information that invites comparison, and straight talk are going to win the day."*

4.4 HbbTV Regulation

4.4.1 *Potential Regulatory challenges*

The digital technologies are changing the way we live and interact with each other, in other words, ICT has became a very important part of our daily life. In order to get the best of these new technologies, there must be some regulations for the protection and guidance of the organization and individuals by giving users ground rules for acceptable use of the equipment.

The convergence of the new technologies have made it difficult to regulate the new converged technologies since the content come from the Internet and is consequently not regulated by current media regulators.

Many issues are raised regarding the content standards and media responsibilities. Since the Internet content, the broadcasting linear TV and the non-linear audio-visual media can be made available over the same platform and device, then the issue concerning the Internet content that often comes from outside Europe and is usually less subject for regulations. The main risk is bypassing current rules that would make those roles inefficient, then the distortion of competition. According to the EBU, the main challenges in this context are[70]:

- *Copyright and content integrity issues.*

- *Fragmentation of European and worldwide markets*

- *Legal and regulatory issues related to user behavior data protection and user privacy   protection*
- *Broadband network congestion*

Lisa Di Feliciantonio[71] discussed in the EPRA meeting May 2012, the lack of digital single market for VOD for example, where the VOD catalogues are not country specific and would benefit from the EU-wide distribution. In her discussion of this manner she appealed that the passive sales should be allowed outside the country of origin and that the current fragmentation in the commercialization of the rights and territorials exclusivity are preventing the creation of the scale.

Laura Sboarina[72] highlighted in the EPRA meeting her concern about the challenges that the Media regulators might face, such as:
- Enhancing the fight against online piracy
- How to guarantee the quality of the EU content for the non EU content
- Licensing
- Territoriality
- Position in the value chain/ distribution platform

Michael Wagner[73](EBU); discussed in the EPRA meeting the main two challenges of the connected TV, those are:

1- Access issue:

- o *Broadcasters' content must remain easily findable and accessible for viewers*
- o *Viewers must be enabled to access any application or portal provided by broadcasters while watching their channels*
- o *Intermediaries must not impair the quality of experience for viewers*
- o *Providers of hybrid TV portals and other intermediaries must guarantee non-discriminatory access*
- o *Audiovisual programs must be properly referenced by media search engines*
- o *On-demand rights clearance by broadcasters must not be unduly hindered*

2- Content integrity:
- o *The quality of the user's viewing experience depends on the integral transmission and authentic display of audiovisual content and services*
- o *The integrity of broadcasters' content and the economic value of their services must be protected against overlays and other "parasitic" behavior by third parties*
- o *Overlays on the television picture should occur only following an active decision by the viewer ("opt-in")*
- o *While viewers may wish to aggregate content from different sources, there must always be a clear identification of the content sources.*

4.4.2   Potential regulatory solutions

Many issues were discussed regarding the connected TV regulations and many challenges are facing the regulators regarding those issues. In order to help regulating the content, the ETSI specifications for the HbbTV application, defined two levels of trust:

- o Trusted: for the broadcast- related application
- o Non-trusted: for the broadband- independent application

In ETSI specifications[74] there is a suggestion to modify the trust level for the applications where the terminal can play a big role in these modifications as follows:

- Allow user to configure specific broadcast- independent application as trusted and vice versa for the broadcast- related application from a specific channel or service. For example: the adult channels should not be trusted unless the specific user approves it and in agreement with appropriate regulation.

- Applications from non-regulated channels should not be automatically trusted. For example: the HbbTV application does not require trusting channels from cable or terrestrial.

- If different regulatory requirements are applied to different cable or terrestrial channels, the terminals are not required to trust all the applications from these channels.

- Broadcast- independent applications may be configured as trusted by manufacturers and Broadcast- related application as non- trusted.

Local regulations may impose additional requirements.

The 'red button' can be used without signalling [appendix 12.8.3] in such a way, that if the user pushes the red button and there is no signal to the broadcaster's data services (HbbTV signal), some TV sets can use this option to send the user to their own portal or to the broadcaster's website.

5. Services

Services are the core of the HbbTV application, the more attractive services applied on the application the more it will make it succeed and attract more viewers as seen from the ZDF case study where the success of the ZDF- Mediathek made them decided to make sports, news and weather programs available through the HbbTV portal.

The new generation are supposed to be accepting the complex propositions brought up by the Internet, but according to Peter MacAvock[75] this shouldn't be the case with the broadcasters and the CE vendors. The offers have to keep simplicity as it always was in the past and this shouldn't change in the future.

Aggregators/ distributors are trying to find a solution to represent their services in an alternative way to the set top boxes. Jørgen Michaelsen the technical director of YouSee [appendix 12.8.5] is optimistic about the HbbTV, because according to him, they are missing the standard way to deliver their services.

The main goal of the HbbTV solution is to help broadcasters empower their position in the market by keeping the hybrid solution simple for the consumers and add attractive services to the application. The EBU members testify the popularity of the on demand services based on their web-based services including the VOD and the catch-up services. The teletext service as well in the form of the HTML- based as well is popular according to MacAvock. The third most popular service is the weather application.

After analysing the market we found out the most popular services are the on demand service in VOD and catch-up TV forms, News and the weather.

In a discussion with Kristoffer Bo Jørgensen [appendix 12.8.1], about the most beneficial services for YouSee, he explained YouSee's need for the VOD service in the HbbTV, since most of their revenues come from that service.

Jacob Sørensen explained the need for the sports service beside the VOD, the weather and the Highlights, which was because YouSee have a partnership with a new sports channel called "Kanal Sport", so adding the service sports where you can read more about sports news and bet on the sports will add value to the HbbTV application at YouSee.

From the above analysis and interviews a decision was take to add the VOD, Highlights, Weather and Sports services to the HbbTV used by YouSee.

Before discussing the scenarios of the different services, the characteristics of the services will be discussed in the following sub-chapter.

5.1 Characteristics of the Services

5.1.1 Interactivity

For the Hybrid TV, interactivity means that the viewers can interact with the TV content, application content, but it does not mean that the audience can change the storyline of the broadcast channel. According to Günther Hölbling[76], an interactive application offers different levels of interactivity:

Level 1 - Basic TV: basic functions for watching TV, turning TV on and off, changing the channels.

Level 2 – Call-In-TV: telephone call or text messages are used for interaction between audience and broadcaster. Example: TV shows where audience can select a music video using text message.

Level 3 – Parallel TV: suggest different content on multiple channels. The audience is able to change the way they view a broadcast content. Example: change the sound/subtitles depending on desired language.

Level 4 – Additive TV (also known as enhanced TV): Well know example of this level on interaction is Tele-text. Also, EPG or synchronized program-related services are advanced examples of this.

Level 5 – Service on Demand: The viewer is able to consume content independent of the TV schedule. This kind of interaction requires the return channel between the user and content provider.

Level 6 – Communicative TV: In addiction to broadcast content, online services can be accessed. Example: chats, social networks, email, etc.

Level 7 – Fully Interactive TV: The viewer is able to create his/her individual storyline for program. At this level, the program is presented as a kind of video game in which the user decides what is going to happen next.

Nowadays Levels 4, 5, 6, can describe most of the interactive TV (iTV) applications. Application on Level 7 is still being developed.

Nowadays, HbbTV is not the only technology for interactive TV in the market, but what differs HbbTV from the rest is that it enables an extension of the broadcast services to be delivered through the IP connection and provide an all-in-one audience experience of the broadcast content. The ZDF and DR case studies are examples on interactivity with HbbTV.

5.1.2   *User-centrism*

To keep track of the recent development of multimedia, the user-centrism concept is considered to be one of the techniques. Reiterer et al.[77] defines the following requirements for the multimedia systems:

- *Easy access to available content repositories:* the focus here is on the integration of the content that is provided by different resources and a common way to use it.

- *Context awareness*: the information is used to provide continuous use of the multimedia content.

- *Session migration*: in this requirement the user should be able to take media sessions with him by migrating the sessions from one device to the other.

- *Content adaption*: for a satisfying media experience, the content is personalised to the specific target device characteristics and properties.

5.1.3   *Personalisation*

The meaning of personalisation is to provide a person centred services to everyone. It is the process that enables people to have more control on the services they receive. For example, ppersonalized news can be presented to the viewer according to his likes/dislikes or habits. This could be realized with HbbTV[78] using cookies on the TV set or STB. The cookies could store a user ID or user profile. It could be implemented as follows:

- An HbbTV application could suggest news items according to the viewer's habit.

- Or an HbbTV application could suggest news items according to User's favorites.

The entry point for such an application could be the regular linear broadcast program. It is possible to share user ID's and favorites, even though the first version of HbbTV does not include the sharing concept, between collaborating service provides. The HbbTV broadcast-related application is always part of a broadcast service or of multiple broadcast services provided by cooperating broadcasters. The personalized advertising is also possible, but it is limited to profile information.

In order to make the services personalized, data from the users should be collected to fill the users profile. In other words, there should be something that identifies the user profile and describes him. According to Günther Hölbling those are the methods that are used frequently to collect the data:

- Implicit: observing user's behavior is the method to collect the data. This means, that user interests are being associated with the content that the particular user has consumed. Recommendations can be based on the user's action and/or similarities with others users. This kind of data collection doesn't require user to do anything unusual from his ordinary actions, using this kind of approach the data can be collected easily. However, it's often difficult to interpret. For instance, what is the key factor in the user's choice of watching a particular movie: genre, director or actor?

- Explicit: data is being collected by directly asking the user to rate the content. This kind of approach ideally would provide a very useful and high quality feedback, so this data can be interpreted easily rather than the one gathered using ‚Implicit approach. However, it requires the user to perform extra actions, which often bothers the user and leaves the question unanswered.

- Hybrid: combines both ‚Implicit' and ‚Explicit' methods. For instance, explicit method can be used to collect basic profile data such as: user location, age, etc.,

When personalizing a service with TV, the key factor is the viewers and to what degree of personalization should this specific content be personalized. The following are the categories of the degree of personalization:

- Individual: recommendations are based on a user's likes and dislikes. Generated recommendations are presented to individual users

- Group-centered: recommendations are generated to group of users based on their similarities, such as age, location, etc. The recommendation is being addressed to the whole group of viewers.

- Mixed: in this category, both individual and group-centered methods are combined to a certain degree.

To be able to categories the degree of personalization, we need to identify the user. So the users can be categorized as follows:

- Anonymous: recommendations are addressed to the user without identifying the current user. This kind of recommendations often is not correct as they are generated based only on the users interaction with the system.

- Pseudonym: the user is tagged with the source of identification, the pseudonym. The real user's identity is hidden behind his or her pseudonym. In this category, the recommendations are generated on a well-rounded view of particular user's interaction with the system.

- Full identification: The user provides his personal data. This category can provide the most accurate recommendations, however, often refused by the user, because of the privacy issues.

  Personalization in terms of Hybrid TV can play the huge role while aggregating the content and serving it to the particular user. However, there are some serious barriers of personalization: purely designed systems interface; users refuse to provide the personal data due to the security issues, etc.

  Different methods and techniques have been developed to optimize the personalization and make the recommendations as accurate as possible.

5.1.4 Convergence

Convergence means that several technologies can be merged into the single network to form a myriad of media. Historically technology accomplished one task or two, meaning that each entertainment mediums had its specific device, such as the video needed a video player to be played on television. Nowadays, through the convergence of technology, devices are able to present and interact with a wide array of media. Ten years ago, we couldn't even imagine that in future we could watch a TV show and interact with talk show hosts and their guest in real time. A good example on its existence is the Russian Internet TV MineavLive[79] where audience can interact with show hosts and their guests using social network websites, such as twitter and Facebook and have a live conversation with show hosts and guest using Skype.

Figure 26: MineavLive - Russian online TV

In terms of technology, it is very inconsequential: a show has a couple of Skype accounts that are available for calls. The users can call using any device that can run Skype (in our case a TV with webcam).

Even though it might seem very trivial, but as seen on the above image the number shown is for the number of live viewers in addition to the offline viewers who watched the show as a catch-up.

Moreover, if we could serve the linear content via broadcast and the return channel via broadband it could make it even better, it could serve the better quality in more convenient way by taking the best from both broadcast and broadband.

5.2   Scenarios:

A fundamental tool in designing a business model is the story telling that can guide us to focus on the user's requirements, which are different from the technical, or the business requirements. It describes how the users can interact with the system, in other words it describes the system interaction from the user's perspective. The interactivity that HbbTV provide must fulfil the 'lean back' interaction where we have to take into consideration while designing the service that the users are typically relaxing in their living room and using a simple controller to control the TV with, which is the remote control.

The services chosen covers a variety of users need from a TV application:

-   Video On Demand (VOD) service will be designed for the users who wants to rent Movie on demand direct from the TV

-   Highlights service will be designed for the users who want to check the RSS feed from the News.

-   Weather service will be designed for the all types of users, where the application will provide information about the weather for different regions in Denmark.

-   Sports service will be designed for sports fan; the application will provide RSS feed from the different Sport channels.

In the following sub-chapters there will be a description for the services scenarios that will help us explore the customer's needs regarding the HbbTV application.

5.2.1 VOD

A group of young people wants to meet and hang out, but they don't have money because it is at the end of the month, so one of them invites them to his parents house where they have an HbbTV enabled TV set.

He turns the TV on YouSee's info channel and clicks on the red button to enter the portal that is provided by the broadcaster. A menu with different services appear and he chooses the VOD service, and a list of movies to chose from will be appear, the broadcast signal will be running on the background of the application in a form of minimized screen until the user selects a movie to start watching.

After selecting the movie the user will be able to read a brief description about story of the movie, the actors, the genre, the director, etc.

When the movie is chosen to start, the user will be able to maximize to the full-screen format, play, stop, pause and check the progress line of the movie that indicates how much time left for the movie.

When the movie is done, the user can either go back to the HbbTV application menu or exit the whole application and go toe broadcast signal (the live signal from the broadcaster).

5.2.2 Highlights

A family man who wants to watch news on regular basis, his family decides to watch a movie that coincides with the time for the daily news. The father is forced to watch the movie instead of knowing what is going on around the world so that he don't upset his family.

After the movie is done, he pushes the red button that will lead him to the broadcaster's HbbTV portal where he will chose the 'Highlights' from the menu and check the news that he missed because of the movie.

He will be able to read the news from different broadcasters by clicking on the broadcasters name button and the highlighted news will appear on his screen.

5.2.3 Sports

A spots fan that wants to be always updated on the different sports news, he can use the HbbTV sports service that will provide him with the highlighted sports news from different broadcasters.

If he has a TV set that can be connected to the Internet, he can at any time enter the application provided by the broadcaster using the red button and click the sports service.

When he finish browsing the different highlighted sports provided by different broadcasters, he can always exit the application and go back to the broadcaster live streaming or go to the application home where he can choose another service.

5.2.4   Weather

In Denmark you can't go outside without checking the weather, you need to know if it is sunny or rainy especially in the period between spring and autumn. In winter you know that it is going to be cold, whereas in the summer it is unsafe to go outside with light cloths where you need a raincoat.

A user can at anytime use the red button to enter the application provided by the broadcaster and choose the weather service from the menu to check the weather according to his region. He can also chose another region from the list of regions to check the weather. And after he finishes he can simply press the exit button to go back to the original signal unless he wants to use another service from the HbbTV application.

6. Analysis

6.1   System requirements

The requirements are the result of market analyses [business model Nilma] and HbbTV application required by YouSee. The HbbTV application contains VOD, Weather, Highlights and Sports.

6.1.1   Functional requirements

Functional Requirements (FR)	
FR1	The system should show red button on HbbTV related program for 5 seconds
FR2	The system should show HbbTV services when red button is pressed
FR3	The system should return to broadcast program on exit
FR4	The system should return to services menu when home button is pressed
	VoD
FR5	The system should minimize the broadcast content
FR6	The system should allow the user to select a video from the list

FR7	The system should allow user to control the video i.e. play, pause, stop, maximize and minimize.
	Weather
FR8	The system should allow the user to select a city from the list
FR9	The system should show the weather details
	Highlights
FR10	The system should show highlights
	Sports
FR11	The system should show sports events

Table 1: Functional Requirements

6.1.2   *Non-functional requirements*

Non-functional Requirements (NFR)	
NFR1	The application shall be implemented using php, javascript, css, jQuery and HTML
NFR2	The system shall use Apache web server
NFR3	The system shall use IRT broadcast server
NFR4	The HbbTV application shall run on the computer browser
NFR5	The system shall notify the user if there is no broadband connection in the middle of the HbbTV application.
NFR6	The system shall show the status of the video i.e. playing, buffering, progress and duration
NFR7	The system shall show video details
NFR8	The application shall be extensible

Table 2: Non-Functional Requirements

6.2   Use case diagram

On the basis of system requirements, we came up with use case diagram that captures the system's behavioural requirements. The user is an actor who acts, e.g. a TV viewer in our case.
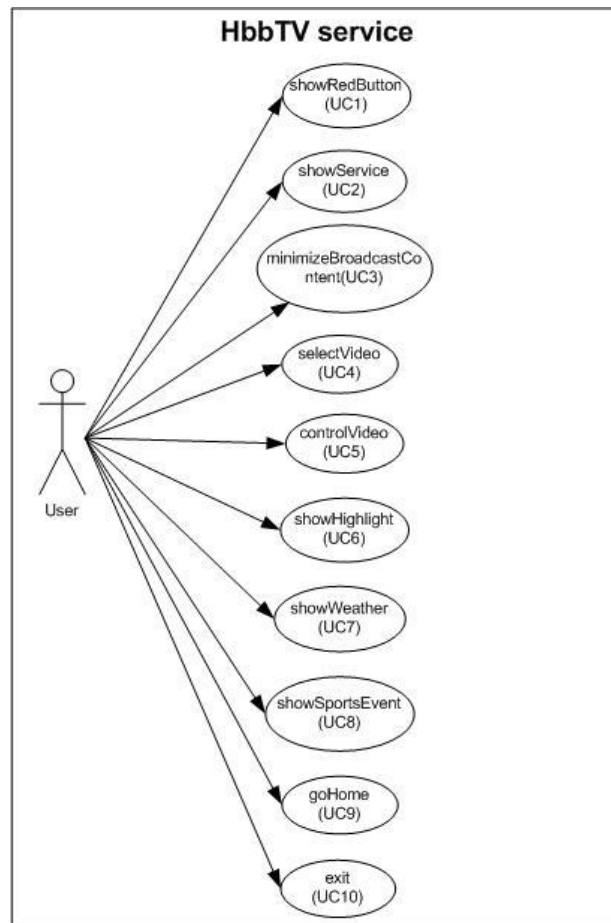
Figure 27: Use Case Diagram

Each use case is described in use case specification section below:

6.3   Use case specification

In the following tables we will describe the behaviour of our system according to the use cases realized on the basis of functional requirements of the system. Here, we have included only two use case specifications, the rest can be found at [appendix 12.1].

Use Case: showRedButton
ID: UC1
Brief description: The system displays the red button on broadcast content for 5 seconds.
Primary actors: user
Secondary actors: None

Preconditions:
      Broadcaster server is running.
      Web server is running.

Main flow:
• It displays red button on the broadcast content.   • The user presses "red button" from remote control.
Post-conditions: - A representation of the HbbTV services i.e. VoD, Weather, Highlights and Sports.
Alternative flow: User clicks the red button before it shows up for the first time.
Post-conditions: Nothing happens.

Table 3: UC1 specification

Use Case: selectVideo
ID: UC4
Brief description: The user selects a video to play from the video list.
Primary actors: user   Secondary actors: None
Preconditions: UC1, UC2 & UC3 exist.
Main flow: • The user selects a video from the video list.
Post-conditions: - The system hides minimized broadcast content.   - The video plays on minimized broadcast content.
Alternative flow: The Internet goes down in the middle of playing video.
Post-conditions: It stops playing video and starts broadcast video.

Table 4: UC4 specification

7. Design

In this section, we will discuss about the service design and a sequence diagram of our first hello world application.

7.1 Services design
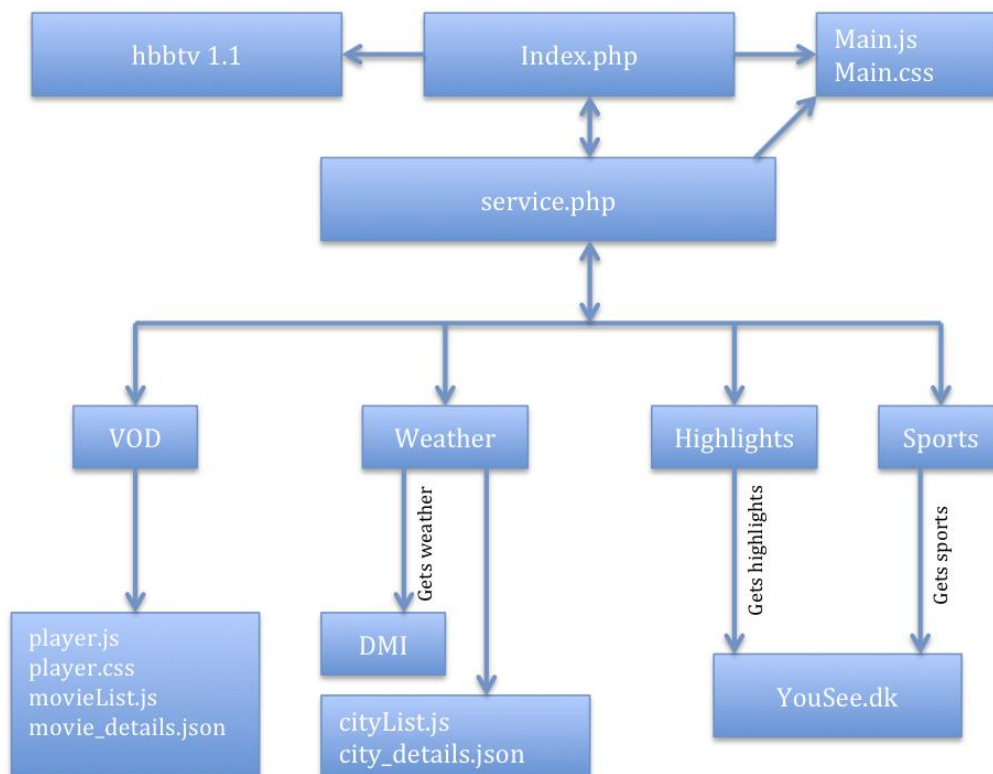
Figure 28: service design

Index.php uses hbbtv1.1 library that is embedded in the HbbTV terminal. It uses Main.css for the design layout and Main.js for the functionality. It is responsible for showing/hiding red button, creating/destroying application and handling remote control. It links to the services when a user presses red button on the remote control.

Service.php has links to the different services (VOD, Weather, Highlights and Sports).

VOD uses player.js to request video and to control video. It uses movie_details.json for the movie details.

Weather, Hightlights and Sports get related information from external site: DMI and YouSee.dk as shown as in above figure.

7.2 Sequence diagram

HelloWorld Service is the first test service we developed for HbbTV. The reason was to start from very basic and realize the basic functionality of HbbTV. We show the HelloWorld sequence here because it is simple to understand and the rest of the services follow the same basic sequence of events.

With autostart

Without autostart
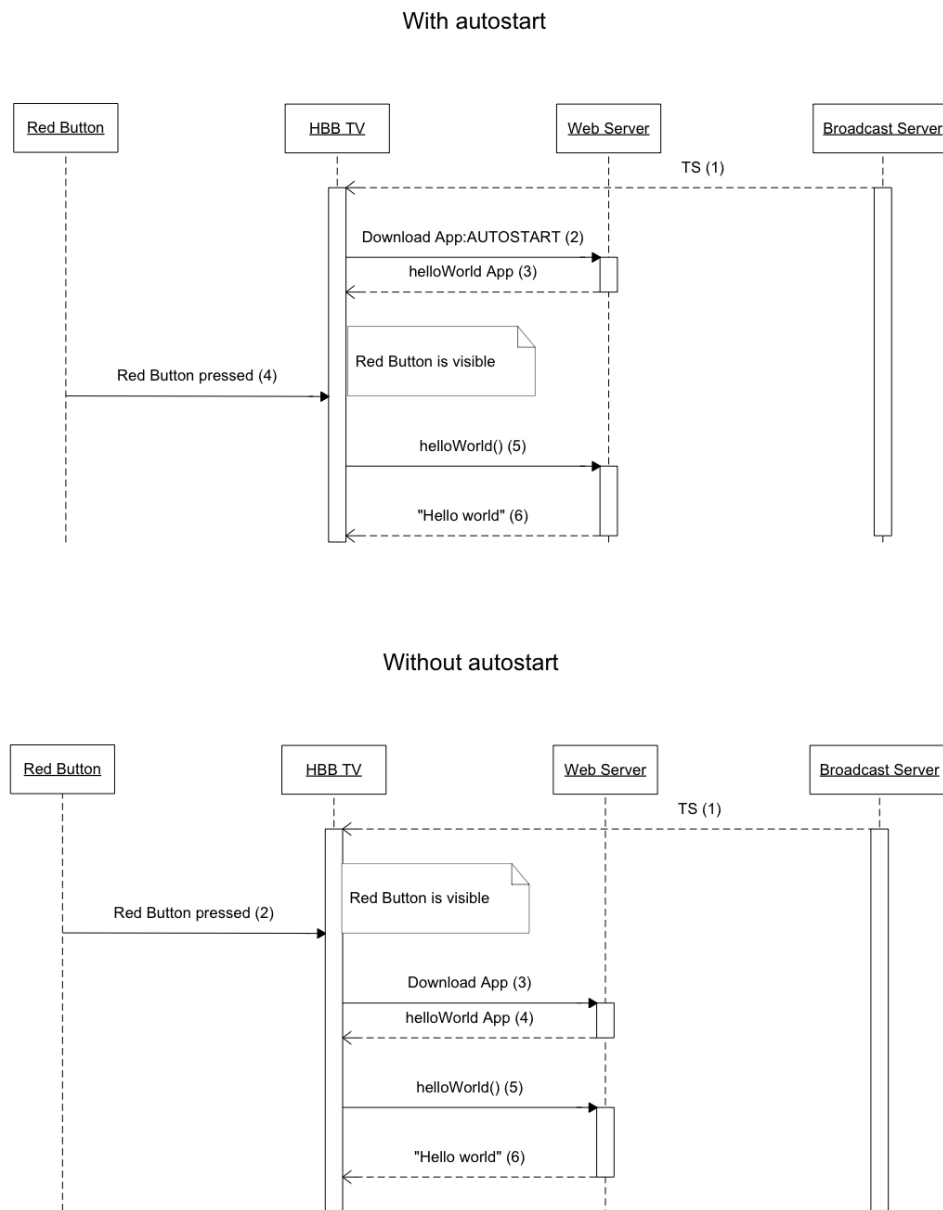
Figure 29: sequence diagram, HelloWorld

8. Implementation

In this section, we will describe some of the interesting specification to be considered during implementation. The source code can be found in the CD.

MIME type and DOCTYPE

All XHTML documents of an HbbTV application shall include either the strict XHTML doctype or the transitional XHTML doctype. E.g. <!DOCTYPE html PUBLIC "-//HbbTV//1.1.1//EN" "http://www.hbbtv.org/dtd/HbbTV-1.1.1.dtd">. The application shall be served with the MIME content type "application/vnd.hbbtv.xhtml+xml". The terminals do not load or run documents which are served with a MIME type other than this.

**CSS and JavaScript standard support**

We have to consider the description of CSS elements, JavaScript API and DOM API that are supported by OITF during implementation. The description can be found at http://www.oipf.tv/docs/Release1/OIPF-T2-R1_DAE_Reference_Guide_v1_0-2010-03-11.pdf

Application life cycle

To create and destroy application you need the following tag in the HTML page:

<object style="width:0;height:0;position: absolute;" id="appMan" type="application/oipfApplicationManager"> </object>

This object can be accessed and manipulated by javascript via its id, in this case "appMan". For example :

```
var appMan = document.getElementById("appMan");
app = appMan.getOwnerApplication(document);
app.createApplication(app_url);
// make application visible
app.show();
// destroy the application
app.destroyApplication();
```

Video Object

For the video object the following tag is needed in the HTML document:

<object style="right: 0px; top: 0px; width: 640px; height: 320px; border:dashed;" id="video" type="video/broadcast"> </object>

The above object is for broadcast content. For the VOD the type attribute must be:

type = "video/mp4".

9. Testing

In this section, we will discuss about the requirements test and user test.

9.1 Requirements test

We tested our application on Sony BRAVIA TV (KDL-32CX525) and Loewe TV (CH-TYP SL150).

Requirements test	
ID	**FR1** (show red button)
Preconditions	Broadcast server is running Webserver is running
Test description	The user selects the channel with HbbTV signal.
Expected result	Show red button for 5 seconds
Actual result	12.5 user manual, Step 1
Result	Passed

Table 5: FR1 test

Requirements test	
ID	**FR2, FR3, FR4** (show services, exit, home)
Preconditions	FR1 exists
Test description	- The user presses a red button on the remote control. (FR2) - The user selects exit. (FR3) - The user selects home. (FR4)
Expected result	- Show services (VOD, weather, highlights and sports. (FR2) - Return to broadcast program. (FR3) - Return to service menu. (FR4)
Actual result	12.5 user manual, Step 2
Result	Passed

Table 6: FR2, FR3, FR4 test

Requirements test	
ID	**FR5, FR6, FR7** (minimize broadcast content, select video, control video)
Preconditions	FR2 exists

Test description	- The user selects VOD. (FR5) - The user selects a video. (FR6) - The user controls the video. (FR7)
Expected result	- Minimizes the broadcast content. (FR5) - Allows the user to select video. (FR6) - Allows the user to play, pause, stop, maximize and minimize the video. (FR7)
Actual result	12.5 user manual, Step 3
Result	Passed

Table 7: FR5, FR6, FR7 test

Requirements test	
ID	**FR8, FR9, FR10, FR11** (minimize broadcast content, select video, control video)
Preconditions	FR2 exists
Test description	- The user selects a weather service and selects a city from the list. (FR8) - The user selects Highlights from the service. (FR10) - The user selects Sports from the service. (FR11)
Expected result	- List of cities. (FR8) - Show weather detail. (FR9) - Show news highlights. (FR10) - Show sport events. (FR11)
Actual result	12.5 user manual, Step 4, 5 & 6
Result	Passed

Table 8: FR8, FR9, FR10, FR11 test

9.2 User test

We have tested our application with one user who has no idea about HbbTV. The only information we provided him with was, when the red button appears on the screen, push the red button on the remote control to access the service.

Basically, he found out that the application was interesting. However, he has some comments on user interface. For the better understanding of the application, please check appendix [12.5, user manual].

VOD

For the video on demand, he was in doubt how to use the buttons, because he is used to use the "RETURN" button on remote control to go back. But in our case, we are using arrows. He also suggested having help menu on how to use the service before he starts using the service.

He wants to be able to get information about the movie before starting it. He wants, when he clicks on pause, then the focus should be on play button.

Weather

His main question was, "Do I need arrows to navigate?" He suggested that, there is no need for the extra arrows.

Sports

He wanted to be able to select the advertisements and get more information about them.

10. Business Model

There are many concepts that define the business model, some of them focuses on the individual company while others takes into consideration the network of companies involved in the business[80]. As for the Hybrid Broadcast and Broadband TV (HbbTV) there are a variety of business models[81] such as:

- Public value service: The Arte+7 push-catch-up TV application

- Commercial Free TV: The ProSieben's added banners on the pages and per- roll- ads

- Commercial Free TV: The XDF's linking of advertisement applications

- Pay Video on Demand (VoD)

Since this project requires cooperation and transaction with other actors to establish this type of businesses and cannot be considered as a stand-alone product, then it is a good idea to look into the business model from the network of companies' point of view and not a single company approach.

This project will only highlight the important considerations for the HbbTV business model since according to Jacob Jørgensen product manager at YouSee [appendix 12.8.1], they want to use the concept DR used where they make a HbbTV application test, launch the application to the public and observe the application for errors and the audience reaction on accepting the new technology without having a finite business model.

In the following sub-chapters, an analysis of the business model describing the network approach by Pieter Ballon[82] and Faber.et.al[83]. The business model is divided into four different sections according to this approach:

- Service design

- Organisation design

- Technology design

- Financial design

10.1 Services design

This part of the business model deals with the 'value' that the service will provide to the end users, in this case the TV audience. In order to do so, the target group or the early adopters of the HbbTV should be identified; to know the type of services the application should provide the users. Interviews with service providers were taken place during this project and a market analysis of the TV and the viewers that are using their TV sets to browse the Internet.

The use case scenarios described in section 5.2 shows the services that are results of the market analysis and the interviews with the service providers. The result simply reflects the most popular services in the market and the services that are more beneficial to YouSee in HbbTV universe.

In order to design the GUI, the ten Usability Heuristics defined by the Danish Interaction Designer Jakob Nielsen[84] were used:

- Visibility of system status

- User control and freedom

- Match between system and the real world

- Consistency and standards

- Error prevention

- Recognition rather than recall

- Flexibility and efficiency to use

- Aesthetic and minimalist design

- Help users recognize, diagnose and recover from errors

- Help and documentation

    The image below shows the simplicity in designing the GUI for the HbbTV to make it a user-friendly application:
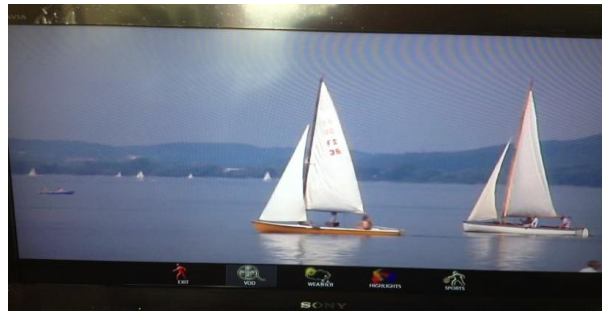
Figure 30: Menu page of the HbbTV application

The main purpose of making the application easy to use is because; the time the users spend watching TV is within their relaxation time. So the application has to be as simple as possible so that it does not lose its value.

Figure 31: VOD service start page in the HbbTV application

The value proposition parameters for HbbTV application:

• Positioning: the services that the HbbTV application will be a complementary for the broadcast content.

• Customer involvement: users play an active role in assigning meaning and value to new products and services. Even though in the HbbTV case there is no involvement of the customer but it might have an indirect effect on it, this is why the service is built by focusing on the user needs. And as explained before, simplicity in this type of applications is what makes it more popular and gives it its value in the market.

• Intended values: the case of HbbTV fits in Pieter Ballon's[85] three strategies for the intended value:

  o Operational excellence: dropping the price of the product / service below the level will attract a critical mass of users.

    o Product leadership: innovation and premium quality that comes in a premium price.

    o Customer intimacy: an intimate relationship between the service provider and the customer can be seen as an advantage from the customer's perspective, and he will be willing to relinquish some of the privacy for a custom- made solution.

But for the early stages of HbbTV, the operational excellence will be the most suitable strategy.

The services that YouSee intend to promote are:

- Video on Demand (VOD)
- Highlights

10.2 Organisation design

The organisation design describes the value network of the service with three important factors[86]:

- Actors: the entity that contributes at some level to the value network.
- Roles: the value- adding activity the actors provide to the service.
- Relationships: the commitment between the actors.

The association between the different partners is the basis for the innovative success and infrastructure of the HbbTV service and the relationship between them has to be defined not only as the relation type, but also according to the necessity to the service.

Innovation creates strong foundation for the service and this will increase its chance to succeed. And since different actors have different unequal roles to contribute with the service this is why they shouldn't be treated equally. And therefore they should be defined as different types of partner:

- **Structural**: These are the important partners to the service, and as a foundation for the relationship a legal contact should bind them. In the case of the HbbTV they are listed below with a description to their roles:

    o Broadcasters: are the basic players of the HbbTV standard, they created the HbbTV standard to protect themselves. They are the owners of the content and they have a full control on it, in some cases they also rent the content

    o Distributors/ Aggregators: they can be the heart of the system because they work on the technical, editorial, sales and marketing. A distributor may have financial relationships with advertisers, for its own applications or applications offered by

vendors. Distributors, in the broadest sense, appear best positioned to create new interactive services.

- o Broadband: network providers will be playing a crucial role in the delivering of the services on the HbbTV devices. Their interest in this situation is connected with utilization of their resources. However, the quality of the service will affect the service delivery and may become a barrier for HBB TV. So they can take advantage of the HBB TV in that the customers might need to upgrade their subscriptions to get better HBB TV quality service.

- o Customers: from the financial perspective the customers are the ones providing the basis to the success of the service, beside that they play a big role in todays personalisation factor, which is an important characteristic for the HbbTV service, with providing personal data that will be helpful for the commercial aspects in terms of innovation. The loyalty of early adaptors helps building a foundation to reach the majority of users.

- o CE Manufacturers: hey have the ability to interact the devices with the Internet. Some of them have already started their online services portal by integrating their own applications and services, and defining their business model, including marketing offers advertising space to advertisers.

- **Contributing**: those partners are the ones who provide the service with special services or goods that will be helpful in developing and maintaining the service, however replacing them will have effect on the service (may be make it better), but the business model will not fall apart.

  - o Media providers: their role is to provide a wide range of content that will be used to add value to the service for example the VOD service.

  - o Application developers: those are the ones who will design and develop the HbbTV; they will build the foundation to the different actors who will use the HbbTV to add their services, such as the advertisers. Moreover, they will be the ones who will be updating and testing the application.

  - o Advertisers: those are the ones who will use the HbbTV to add value to the business model because they are important for the revenue of the service. They can use the HbbTV in different ways, for example adding banners on the application, linking the application to their own links, etc.

  - o Legal advisors: their role is to give legal assistance, writing contracts, making legal negotiations between different parties interested in the HbbTV development

such as aggregators and broadcasters. They can also play a role in finding legal solutions for the HbbTV regulations.

- **Supporting**:
  - o Bank: those will provide the safe transaction between the customers that are using the HbbTV for the VOD and renting movies for example and the broadcasters.
  - o Data collectors: the role of those is to provide data storage and management of the users, that data will be used to help personalise the content of the application and make it more popular.

Relationship between the different stakeholders

Since the HbbTV was created to support the broadcasters, there become a conflict between the stakeholders (aggregators/ distributors and broadcasters) on who would have control on the 'Red button' that gives access to the broadcast related application, because the broadcasters could have the control on the 'Red Button'. So other stakeholders (aggregators/ distributors) would suggest having a parallel mechanism that allows them to work across all channels in their platform and not only the broadcast related channels (example TV2, DR), such solution would be a 'Green Button' for example. [Appendix 12.8.2]   Another conflict between stakeholders would be between the broadcasters and the manufacturers; the major TV manufacturers want to have their own market place, such as Samsung that is the major brand in Denmark. Samsung TV does not want to provide HbbTV, because it would be competition with their own app store where they go directly to the Internet without considering other players in the value chain. [Appendix 12.8.1] We can now see that the stakeholder relation is a barrier somehow to the Hybrid TV business when it comes to the 'Red Button' conflict. As for the manufacturer conflict with the broadcasters, even though the manufacturers want to have their own business, they still need the content provided by the broadcasters and in this case the broadcasters have an extreme powerful position at least when they stand together.

The value network parameters for the HbbTV application are as follows:

- Combination of assets: in the HbbTV, the combination of assets is concentrated, because as seen from the analysis of the different partners for this technology, the HbbTV relies on different parties.

- Vertical integration: the value chain is disintegrated, because different parts of the production are given to different parties in the value chain.

- Customer ownership: the relationship between the customers and the broadcasters is in general intermediate, but in the case of the distributors/ aggregators (YouSee) the relationship is direct.

10.3 Technology design

In the technology design we deal with the technical aspects regarding the services. The cooperation between the broadcasters and the broadband network providers that Hybrid TV makes the interaction with the broadcasters and the end-user possible by using the regular domestic Internet access. Moreover, users by using a single device will be able to access new services from other entertainment providers (online services, CE manufacturer, etc.).

The HbbTV is an end-to-end[87] system that combines the broadband and broadcast with the use of Internet connected TV devices. It is an improved broadcast system that includes different services such as interactive elements, on-demand services such as VOD and catch-up TV, and other functionalities.

Figure 32: Hybrid TV architecture[88]
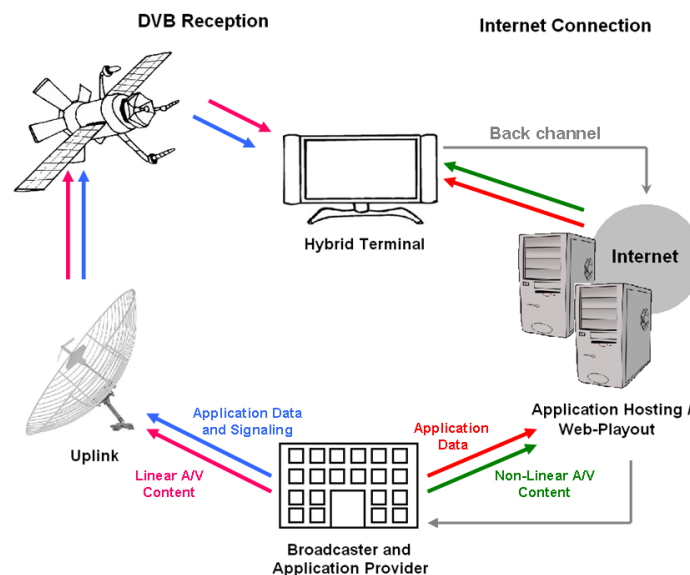
The architecture above contains the hybrid terminal, the DVB broadcast connection and the broadband connection, and this is Typically ADSL or FTTH[89]. The specification for this new technology is based on existing technologies and standards including the DVB (Digital Video Broadcasting), CEA (Consumer Electronics Association), W3C (World Wide Web Consortium) and OIPF (Open IPTV Forum).

The main goal of this new technology is to be a Free-To-Air (FTA) model, but it can also be used in different models such as Pay-TV business model.

The Broadband capacity may be a real issue for the expansion of Hybrid TV since it will impact directly the quality of services that the broadcaster could convey through the broadband, especially, heavy services such as VOD. However, the fast growth in marketed broadband capacity and the adoption of adaptive technologies (adaptive streaming for VOD for example) may help out in the near future.

Below an explanation based on Pieter Ballon's about the functional architecture parameters for this technology:

- Modularity:

The clear example that the HBB TV standard makes it possible to have modularity is the association between the broadcasters and the broadband. Since there is an association, so if we develop the HbbTV application on the Broadcaster, it will not affect the Broadband. And if we make any changes in the Broadcaster side or the Broadband side, those parties will not be affected, but the service will be affected, to a better service.
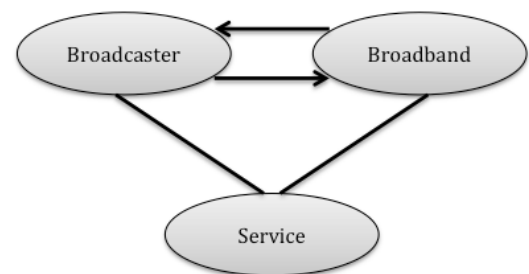
Figure 33: Modularity

- Distribution of Intelligence:

In this case, the intelligence is distributed, because technologically if you want to realize VOD or catch-up TV on Hybrid TV, then the Broadcast signal has to broadcast the location of the service via the AIT table to the terminal to enable the corresponding application. In other words, the catch-up service or the VOD services involve three elements:

1. The broadcast signal: that provide information about the content.

2. The terminal: that interprets the signal and accesses the content.

3. The web server: that will send the content.

- Interoperability:

Interoperability in this case depends on broadcasters interest, for example in relation with VOD, the format of the video is the issue for interoperability. There is interoperability

Figure 34: Distribution of intelligence

with the streaming form MPEG-4. The interoperability will be depending on the broadcaster's interest, for example, may be DR is not interested in having non-interoperability, but may be National Geographic want to standardize the streaming.

10.4 Financial design

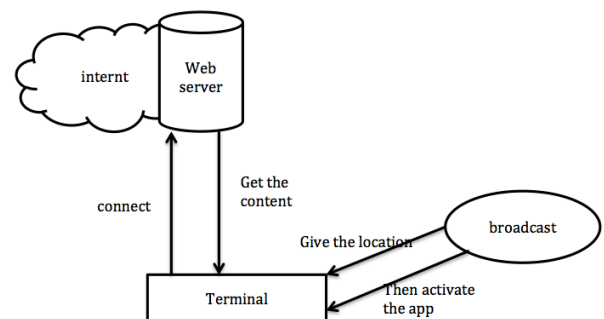The major question to answer in any business model is how to earn money with the service/ product the company is producing. That's why the financial analysis is needed in order to have an overview of any business future in terms of revenues. This part is crucial for any investor and for any stakeholder involved in this business. In other words, financial reporting is critical in order to identify how money and resources are spent, in order to track internal revenue sources, and in order to compare actual results to budgets and forecasts. Weak internal financial analysis can lead the company to overspend or fail to capture key market share due to lack of cash flow and poor planning.

The HbbTV needs a good marketing strategy to assure the success of its launch. Broadcasters need to convince the users that the application is useful.

Major stakeholders (broadcasters, network providers and CE manufacturers) need to create a communication campaign in order to communicate the outstanding quality and the value of the HbbTV services. An example would be having an HbbTV ambassador when commercializing for a TV set in the shops, where he can explain how the application work and show a demonstration from different broadcasters who already launched their application.

As for the pricing strategy, a 'Freemium' will be a good starting point along with the test period for the HbbTV application, followed by a monthly subscription.

The value parameters for the HbbTV will be as follows:

- Cost sharing Model: the cost in this case is concentrated, YouSee will pay for everything and it does not matter how much it will cost.

- The revenue Model: there are two different trade-offs of a choice depending on the application domain:

  o Advertisement- based and customer- paid.

  o On the content and transport (according to the Mbytes).

According to Prasad et al. (2003), advertising and media share a cooperative relation. And he also argue that consumers dislike the large amount of advertisement and a high priced subscriptions, so in the case of HbbTV there can be a combination of the above mentioned trade-offs or choice of:

   o Direct trade-off: paid by customers

   o Indirect trade-off: paid by advertisers

We suggest in the case of the HbbTV a combination between the customer-paid and on the content.

- Revenue sharing Model: since the cost sharing is concentrated, then the revenues will not be shared.

11. Conclusion

In this section, we have tried to gather the answers to the questions raised in the problem formulation.

Easy user interaction

It is better to program a remote control's buttons instead of letting users to navigate to the menus on the TV screen in some cases. For example, PLAY, STOP videos. It is also easier for the user to press "red" button if he wants to go back to the broadcast content directly from anywhere in the application instead of navigating and selecting the "exit" menu on the TV. It can also be, if he wants to go back to the Home menu, he can just press "green" button.

Video

Until HbbTV 1.1 version, the application developer has to use the JavaScript API to control the video. For example, to stop, to play, to pause, to show progress, total time etc. However, HbbTV 1.5 version has already been released that supports MPEG-DASH. This means, if the terminal comes with a support of HbbTV 1.5 version, the developer doesn't have to use JavaScript to control the video object.

DRM

After analysing the different DRM systems, we could see that some are made for a special type of products, such as the Apple's FairPlay DRM that is only compatible with the Apple A/S products and others need a specific plugin such as the Microsoft's PlayReady DRM needs the Silverlight plugin, whereas for Widevine is almost the same case as the Apple's, but the difference is that Widevine DRM is compatible with the android OS. OpenIPM is not updated since 2006. Verimatrix's VCAS DRM can be considered a good hatch for the VOD and Pay-TV because it is specified in protecting this type of services, but in order to do that it uses Marlin DRM for the MultiRights option. Therefore we conclude that Marlin DRM is the best option for the HbbTV, because it also supports MPEG-DASH that is supported by

HBBTV 1.5. Many Countries are willing to standardise the Marlin DRM along with HbbTV starting from Spain and France.

Market

- The services implemented on our application are based on analysis of the popular application market and which are most beneficial for YouSee to add value to their content. The services are: VOD, Highlights, Weather and Sports.

- The HbbTV is a new technology in the market and many broadcasters are trying different types of business models along with it in the test period, therefore we developed a business model proposition and highlighted the important consideration concerning the HbbTV Business model.

- The lack of clear regulation for the Internet content will still challenge the fast adoption of the hybrid TV, but hopefully securing the HbbTV terminal will help in this issue.

12. Appendices

12.1 Use case Specification

Use Case: showService
ID: UC2
Brief description: The system displays the services.
Primary actors: user
Secondary actors: None

Preconditions:
    Broadcaster server is running.
    Web server is running.
    Red button is pressed.

Main flow: • A representation of the HbbTV services i.e. VoD, Weather, Highlights and Sports.
Post-conditions: - A representation of the HbbTV services i.e. VoD, Weather, Highlights and Sports.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 9: UC2 specification

Use Case: minimizeBroadcastContent
ID: UC3
Brief description: The system minimizes the broadcast content.
Primary actors: user   Secondary actors: None
Preconditions: UC1 & UC2 exist
Main flow: • The user selects VoD.

Post-conditions:
    - The system minimizes the broadcast content.
    - The system lists the videos.

Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 10: UC3 specification

Use Case: controlVideo
ID: UC5
Brief description: The system allows user to control video i.e. stop, pause, minimize & maximize.
Primary actors: user   Secondary actors: None
Preconditions: UC4 exists.
Main flow: • The user selects any of 4 player buttons (stop, pause, minimize & maximize) to control video.
Post-conditions: Playing or stopping or paused.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 11: UC5 specification

Use Case: showHighlights
ID: UC6
Brief description:

The system displays the highlights of news.
Primary actors: user
Secondary actors: None
Preconditions: UC1 & UC2 exist.
Main flow: • The user selects "Highlights" button.
Post-conditions: The representation of highlighted news from TV stations.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 12: UC6 specification

Use Case: showWeather
ID: UC7
Brief description: The system shows weather forecast of different regions in Denmark.
Primary actors: user
Secondary actors: None
Preconditions: UC1 & UC2 exist.
Main flow: • The user clicks at "weather" button.
Post-conditions: - The representation of weather forecast in graph. - It describes weather detail of a selected region.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 13: UC7 specification

Use Case: showSportsEvent
ID: UC8
Brief description: The system highlights sport events.
Primary actors: user
Secondary actors: None
Preconditions:

UC1 & UC2 exist
Main flow: • The user selects "sports" button.
Post-conditions: The system shows sports events.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 14: UC8 specification

Use Case: exit
ID: UC9
Brief description: The system exits the application.
Primary actors: user
Secondary actors: None

Preconditions:
 	
    - UC1 and UC2 exist.
    - The user has selected any of the services.

Main flow: • The user selects "exit" button.
Post-conditions: The system takes you back to broadcast live content.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 15: UC9 specification

Use Case: home
ID: UC10
Brief description: The system exits the service and goes back to main menu.
Primary actors: user
Secondary actors: None

Preconditions:
 	
    - UC1 and UC2 exist.
    - The user has selected any of the services.

Main flow:

• The user selects "home" button.
Post-conditions: The system takes you back to main menu.
Alternative flow: If request is illegal, an error message is sent
Post-conditions: Error message

Table 16: UC10 specification

12.2 Server log

Figure 35: Server log

12.3 Server Configuration

Following are the configuration screen dumps of IRT broadcast server.
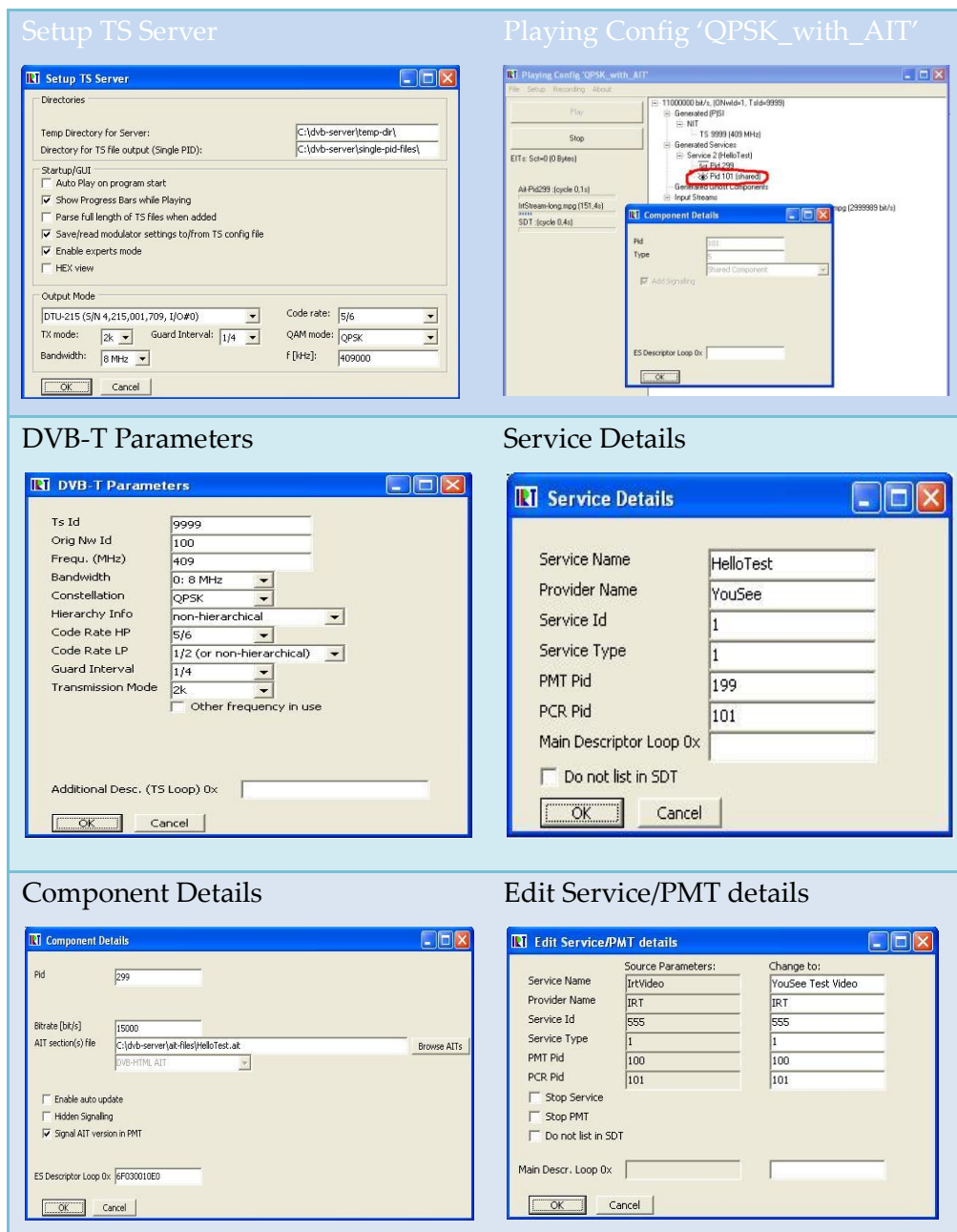
Figure 36: Server Configuration

12.4 Ait table

Figure 37: AIT Table

12.5 User Manual

Step 1:

Red button will show up for 5 seconds on the broadcast content as shown as in figure below. You have to click on "red button" on the remote control to access the services.

Figure 38: red button

Step 2:

If you press the red button, you will see the available services as shown in figure below:
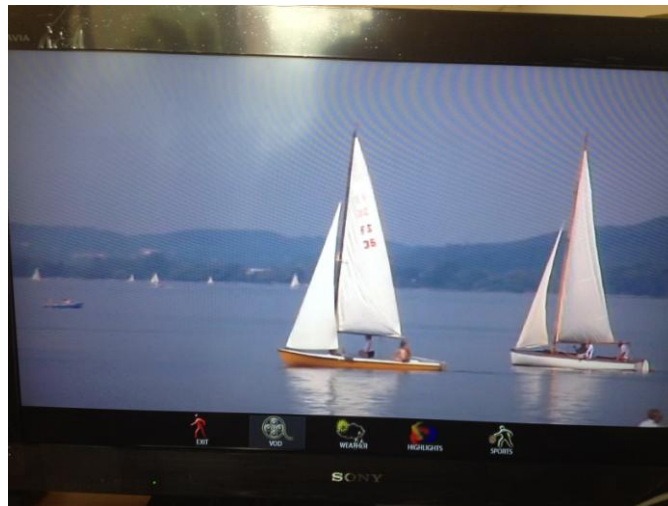
Figure 39: HbbTV services

Step 3:

You can select any of the available services. For example, VOD as shown as in figure below:

Figure 40: VOD

Here, you can see the minimized broadcast content, and movie list at the left side. If you select one of the movies to play, you will see the movie playing on the broadcast content area and also, the movie details as shown in figure below:
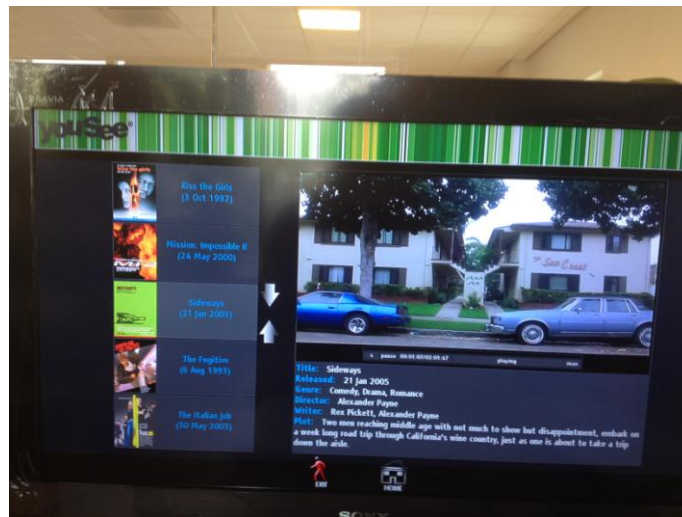
Figure 41: movie playing

If you click at "home", it will show you the available services and if you select "exit", it will take you to the first "red button" area.

You can maximize, minimize, stop and play the movie as shown as in figure below:

Figure 42: maximized video

Step 4:

If you select weather (service), you will be able to check weather of different cities in Denmark as shown in figure below:
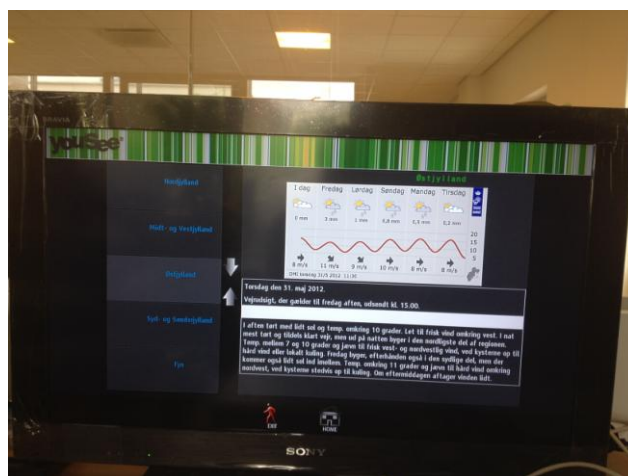
Figure 43: weather

Step 5:

If you select sports (service), you will see the sport events as shown as in figure below:
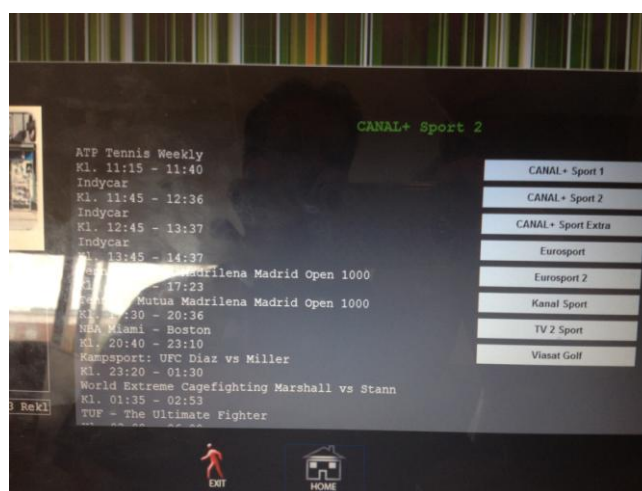
Figure 44: sports

Step 6:

If you select highlights (service), you will see the highlights of news as shown in figure below:
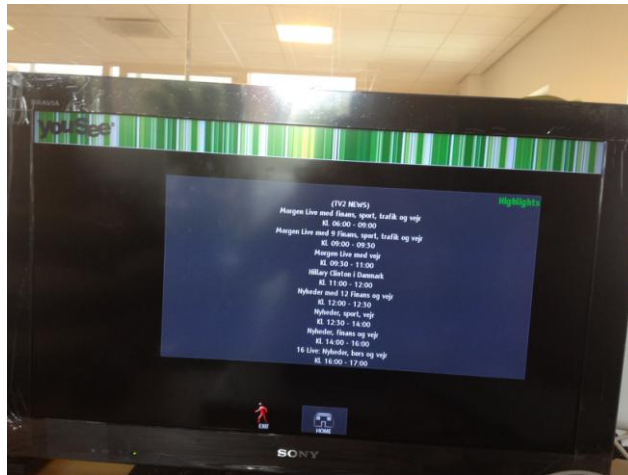
Figure 45: Highlights

12.6 Log files

Group Diary

Wednesday 1st February 2012

Meeting at YouSee

Participants: Ove, Peter, Dan, Reza Tadayoni and us

The HBB TV is discussed.

YouSee explained different components of the system.

They suggested to start with implementing a hello world application

They suggested starting researching for the popular services in the market.

Thursday 02/02/2012 to Tuesday 07/02/2012

Worked individually at home to understand the different system components

Gathered information from IRT.de about IRT broadcast server

The group created the initial milestone plan

Wednesday 08/02/2012

Meeting at YouSee

Participants: Ove, Peter, and us

Discussed our first milestone plan: generally it was accepted with a comment on short time for documentation and only one day for test is not enough.

YouSee has ordered Dektec DTV-215

Tuesday was fixed as meeting with supervisor day

It was suggested to get further acquainted with HbbTV

Monday 13th February 2012

Individually Researched about HbbTV

Discussed the hello world program, tried to understand the different components involved.

Draw to different Sequence diagrams, one for programs with marked as auto-start and one for programs without auto start

Researched the German market for the services.

Tuesday 14th February 2012

Installed the Broadcaster server

Made a small UDP- streaming test, locally on localhost then by broadcasting to another computer (1 PC at the time). It worked on both cases. The test was done using VLC player on the client.

Researched the German Market for services.

Thursday 16th February 2012

Installed the Dektec DTU 215

Installed Apache webserver

Installed PHP

Installed My SQL

Researched the English market for services.

Friday 17th February 2012

Tried to play with output mode: DTU 215

2DekTec DtInfo is installed to check the serial number of the DTU 215.

C:/dvbserver/executable/MhpDataServer.ini is edited by putting extra

[LiveInput] parameters (inspired from the manual)

Still no video is shown on TV. (DVB-S and DVB-C were scanned on TV)

Possibility:

The parameters of the DTU-215 should be configured based on Network information table (NIT) parameters.

Started researching the background of YouSee.

Monday 20th February 2012

We could broadcast video to TV

It was unstable on QAM

We tried with different frequencies, bandwidth and code rate and guard interval.

Frequency=600MHz

Code rate=2/3

Guard interval=1/4

Bandwidth=8MHz

The video was still not stable; it played for some time and stopped or didn't even show.

Researched for the YouSee 's services.

Tuesday 21th February 2012

We could broadcast video to TV

We changed modulation to QPSK.

We tried with different frequencies, bandwidth and code rate and guard interval.

Frequency=405MHz

Code rate=1/2

Guard interval=1/4

Bandwidth=7MHz

The video was stable. So, we added DVB-HTML AIT to the generated service. But, we didn't get any red button application on the TV.

Researched the YouSee Services.

Thursday 23rd February 2012

After some testing, we realized that the generated service ID and input stream ID was the same, i.e. 555.

We changed generated service ID to 1.

We kept the input stream ID the same i.e. 555.

We kept the same modulation as QPSK.

Frequency=405MHz

Code rate=1/2

Guard interval=1/4

Bandwidth=7MHz

But we got the video on one channel (1102) and the HBB App on another channel (1101). Now the problem how to combine them in one stream. The TV had internally assigned the same name to the channel (1101 IrtVideo). By deleting one of the channels, the problem was solved.

When we tried to run video clip in the red button application, we got an error "dvb://current.ait/9.1f5". We found out the 9 is organization ID and 1f5(501 in Decimal) is the application ID. But in our case, In AIT table, org ID is 1. Therefore, we changed 1f5 to 1 in main.js on the webserver as dvb://current.ait/9.1. This solved the problem.

Researched for the YouSee turnovers.

Friday 24ᵗʰ February 2012

The problem was, we found out that, each time we broadcast input stream, the another channel with the same frequency and bandwidth is created; where one for HBB app and one for video.

The problem was not solved.

However to get HBB app on the top of stream; we had to do the following steps: -

Change generated services – service ID 1 to service ID 555 (because input stream service ID is also 555)

Click on the play button.

Tune the channel to input stream.

Now you will get the HBB app but not the video.

Stop the play button.

Then, edit the generated services – service ID to 1.

Click on the play button.

Now, you will get both services.

Setup

TS setup server (DekTec 2015)	NIT
Code rate: 5/6	Ts Id= 9999
Tx mode: 2k	Orig Nw Id: 100
Guard Interval: ¼	Freq.(MHz): 409
Bandwidth: 8MHz	Bandwidth: 0:8MHz
QAM mode: QPSK	Constellation: QPSK
f (KHz): 409000	Hierarchy Info: non-hierarchical
	Code rate: 5/6
	Code Rate LP: 1/2(or non-hierarchical)
	Guard Interval: ¼
	Transmission mode: 2k

Researched for the YouSee Market share.

Services.

Monday 27ᵗʰ February 2012

We still have the problems of two different channels (HBB app & AV)

We tested with the YouSee demo application.

Then we came up with our own Hello application; the idea is, when the user pushes the red button, it will lead him to menus i.e. Hello and Back. When the user select Hello button, the app will show the info about this app, which is for now a message saying 'Hello YouSee'.

Tuesday 28ᵗʰ February 2012

Solved the problem with the 2 channels

The steps can be found in screen dumps (folder smooth2)

Meeting at YouSee

Participants: Ove, Peter, Dan and us

Discussed our second milestone plan: the Hello app and the services available

Suggestion:

Short-term goal: To have multiple services (a service/ app where you can zap between different channels and the app is still running).

Long-term goal: VOD based on HBB TV on YouSee 's info channel

Check the legal issues with the HbbTV standardizations and the YouSee case.

Thursday 1ˢᵗ March 2012

Researching about a Zap between two services.

For inspiration, watching German channels (e.g. ARD, ZDF)

Nilma participated in DR workshop (12:00-14:00)

Friday 2ⁿᵈ March 2012

Researching about a Zap between two services.

Tuesday 6ᵗʰ March 2012

Meeting at YouSee

Participants: Ove, Dan and us

Discussed the services that could be useful in the HbbTV application and what is next after the Hello_YouSee.

Discussed the zapping between channels and its importance.

Wednesday 7ᵗʰ March 2012

Individual research about the zap between services and channels.

Thursday 8ᵗʰ March 2012

Meeting with YouSee

Participants: Ove, Dan, Christopher, Tommy and us

Discussed the HbbTV standard limitation.

Discussed the services that the HbbTV application can provide and which are the most interested ones according to YouSee product manager.

Friday 9ᵗʰ March 2012

Discussed and summarized the last meeting in YouSee.

Agreed to do research about the HbbTV standard limitations.

Monday 12ᵗʰ March 2012

Individual research about the standard limitations discussed in the YouSee meeting on the 8ᵗʰ of March.

HbbTV application Testing.

Tuesday 13ᵗʰ March 2012

Meeting with YouSee

Participants: Dan, Peter and us

Discussed the HbbTV status

Discussed the difference between channels and services.

Discussed the questions that we should ask for DR, such as:

Zapping between channels

If DR have any objection on adding the 'Green button' to their content and if there would be any violation of the standard to do so.

Thursday 15ᵗʰ March 2012

Tested the Spanish HbbTV application

Worked on the political part of the YouSee Strategy.

Friday 16ᵗʰ March 2012

Tested the Spanish HbbTV application

Worked on the political part of the YouSee Strategy.

Monday 19ᵗʰ March 2012

Discussed our HbbTV design for the services.

Prepared a presentation to demonstrate to the YouSee meeting.

Tuesday 20th March 2012

Meeting with YouSee

Participants: Ove, Dan, Peter and us

Demonstrated our HbbTV design for the services and how to zap between the services.

Agreed on finalizing the DR questionnaire.

Thursday 22nd March 2012

Started working on implementing our design for the services.

VoD

Research for the Web-TV case study.

Friday 23rd March 2012

Started working on implementing our design for the services.

VoD

Research for the Web-TV case study.

Monday 26th March 2012

Started working on implementing different services for the HbbTV application.

Minimized the Broadcast stream content.

Research for the Web-TV case study.

Tuesday 27th March 2012

Discussed the table of content for the documentation

Working on VoD service.

Finalize the web TV case study.

Thursday 29th March 2012

Worked on the progress line for the VoD.

Worked on the economical part of the YouSee strategy.

Worked on minimizing and maximizing the screen for the streamed videos.

Meeting with YouSee

Participants: Ove, Dan, Peter and us

Discussed using the Helix server, since they are using flash in their web-TV and the TV devices supports the MPEG4 format.

Friday 30th March 2012

Worked on the Study cases for the HbbTV

Investigated the DMI API and the Google API for the weather

Worked on minimizing and expanding the VoD video streaming

Monday 2nd of April – Friday 6th of April

Easter vacation

Worked from home on documentation

Monday 9th April

Testing different services (weather service and VoD service)

Investigating where to get the sport information from

Talked to Peter about the Helix server

Tuesday 10th April 2012

Meeting with YouSee

Participants: Dan, Ove and Us

Made a short Demo to show that the application is running

Wednesday 11ᵗʰ April 2012

Meeting with YouSee:

Participants: Jacob Jørgensen (VoD manager), Ove, Dan and Us

Discussed the Business for the VoD in general and what will be the future for the VoD with the HbbTV

Discussed the DRM issues with the VoD

Suggestions from Ove to investigate about the DRM that is best for VoD using HbbTV especially now the MPEG DASH supports the DRM

More details about this meeting in appendix

Thursday 12th April 2012

Working with VOD; video timer

Working with Weather (crawl DMI)

Working on HbbTV case study

Friday 13ᵗʰ April 2012

Meeting at AAU-C

Participants: Reza and Us

Discussed the HbbTV status

Made a short Demo to show our design and discussed why we chose the services we are working on

Discussed the documentation of the report

Discussed the BM for the HbbTV

Monday 16ᵗʰ April 2012

Working on the Business model for the HbbTV

Working on the Weather service

Tuesday 17ᵗʰ April 2012

Meeting with YouSee

Participants: Ove, Dan, Peter, YouSee's Journalist and Us

Made a short Demo for the Journalist

Received the Darwin Server

Worked on the Business Model

Worked on the Weather Service

Installed the Broadcast Server

Wednesday 18ᵗʰ April 2012

Worked on the weather service

Worked on the VOD with RTSP

Worked on the Business Model

Thursday 19ᵗʰ April 2012

Had Problems with the router

Worked on Weather Service

Worked on the VOD with RTSP

Worked on analyzing the Darwin Server

Friday 20ᵗʰ April 2012

Worked on the VOD service

Worked on the weather service

Worked on the Business Model
Monday 23rd April 2012
Worked on the VOD service
Worked on the weather service
Worked on analyzing the case studies
Tuesday 24th April 2012
Worked on VOD service
Worked on the weather service
Worked on analyzing the case studies
Presentation for DTU at TDC

Thursday 26th April 2012
Worked on VOD service
How to list movies using JSON
How to scroll up and down
Worked on analyzing the case studies
Friday 27th April 2012
Worked on VOD service
How to scroll up and down
Circular scroll up and down functionalities.
How to minimize and maximize video
Worked on business Model
Monday 30th April 2012
Worked on VOD service
How to position player button on maximizing and minimizing video.
How to toggle between buttons: - pause/play & maximize/minimize.
Worked on business model
Tuesday 31st April 2012
From this date worked further in the implementation and researching for the limitations with the HBB TV standard in addition for documentation.
Tuesday 22nd May 2012
Made a user test

12.7 Action Item List

No.	Item	Status	Responsible
1	Motivation and Background	Closed	Group
2	Problem Formulation	Closed	Group
3	Methodology	Closed	Group
4	Milestone Plan	Closed	Group
5	Structure of the report	Closed	Padam
6	YouSee A/S	Closed	Nilma
7	Hybrid Broadcast and Broadband TV	Closed	Homayoon
8	Adaptive Streaming	Closed	Padam
9	DRM	Closed	Nilma
10	IRT Broadcast Server	Closed	Padam
11	ASI Output Server	Closed	Padam
12	TV	Closed	Nilma
13	Limitations	Closed	Group
14	Potential HbbTV Market	Closed	Nilma
15	Case Studies	Closed	Nilma
16	Customer Requirement	Closed	Nilma
17	HbbTV Regulation	Closed	Nilma
18	Services	Closed	Nilma
19	Characteristics of the services	Closed	Nilma
20	Senarios	Closed	Nilma
21	System Requirements	Closed	Group
22	Use Case Diagram	Closed	Padam
23	Use Case Specifications	Closed	Padam
24	Design	Closed	Group
25	Implementation	Closed	Group
26	Testing	Closed	Group
27	Service Design	Closed	Nilma
28	Organisation Design	Closed	Nilma
29	Technology Design	Closed	Nilma
30	Financial Design	Closed	Nilma
31	Conclusion	Closed	Group
32	Server Configuration	Closed	Homayoon
33	Server Log	Closed	Homayoon
34	AIT Table	Closed	Padam
35	User Manual	Closed	Padam
36	Action Item List	Closed	Group
37	Group Contract	Closed	Group

12.8 Interviews

12.8.1   Product manager interview- YouSee

Jacob Jørgensen (head of VOD department)

… We want to do the same as DR for the HbbTV to make it as a test, launch it to the public and observe without having a finite business model and of course to test for errors in the application if any…

… But in fact DR do not own its content which is a bit strange because when we buy for an instance a public channel from DR we are not actually buying it from CopyDan who some kind of care take of the night of DR, so DR could have to buy somehow their own content from copyDan if put down a very stringent interpretation on the nights and so on, there are couple of unresolved issues copyDan is taking care of all the nights of the info channel we pay some coda for the music. We deal a lot with copyDan.

I mean we have DR in our archive for the STB's. Currently we pay to copyDan a fair amount of money to be able to do that and Dr couldn't actually object to it, they couldn't stop us if copyDan decided to so they just do it. So it is a bit strange to see how all that works out.

…But anyhow we will be able to put the DR's service on our service but that's only a test, there will be no obligations because it is only a test. And we are free to do whatever we want for 6 months. That's where HbbTV is right now.

It is pretty much in the explosion phase, so everybody needs to figure out what can this do what cant it do. For an instance, can it do flash?

Apparently not!

That sort of thing so we can figure out what's the underline business model?

What are the agreements that need to be in place?

How will the nights actually be handled?

What will be the security demand when it comes to DRM condition access?

So I think for our part putting the DR feed into our network gives us a very quick ready test for whether it actually works.

…..That's the content management for now it is the most relevant because it is all clear content. I mean we would be able to not protect it. It is TV and it would be feasible. Of course it raises the question of whether or not it belongs on the individual channels or on a centralized? The next category of stuff would be our movies and our series to be on VOD offering which is stuff that we solve ourselves, so we go to the TV studios and say we will have you and buy it from them. Again we have to pay copDan and the pay per view for people for something. So in that content (VOD) we can do pretty much what we want with. I suppose to say catch-up on Discovery channel; then Discovery channel will have some pens on how that should be presented. A lot of the broadcasters are very afraid of going the iTunes direction where you go to shop music and buy individual track without really looking at what label could this album be, who is actually the artist, which album he comes from? So the track comes completely separate from the content. And the broadcast is very concerned about the catch-up services to become just a big catalogue mixed across channels and I think the theories probably overstate a little bit because I think the Discovery brand for instance is

a really good brand, so if I have to do a catch-up, I have to contact the Discovery people and make an agreement, so that is for the content side. The VOD stuff suffers from a lack of DRM technology. So that's middle to long term. But on the other hand it is pretty interesting stuff. I mean, where we see it, there is a lot of growth and it is easier because we controlled everything ourselves and it is probably the one area where we saw music goes from digital to physical like iTunes and killed almost all the record shops. That's happening with films and series. I mean right now Blockbuster is really having a hard time and there is a big market for selling DVD boxes of different TV shows and so on, that's going to change. I mean it is moving online and it is moving pretty fast. There's gab in the market especially if you can bring it to people on the big TV screen at home, that's the real issue, because we have online videos and you can rent videos online and it's not a problem, but you should need to have them on the big screen.

Do you think that the video issues will be a problem when talking about the VOD via the HbbTV?

We currently have the real comparison we have a smart TV Samsung widget that does stream TV with flash and I think it is, I mean I look at the STB quality and so on, I don't think I could bare to watch it, but we do got a surprising large number of rentals and views through that widget, way more than we actually expected.

But I think there is no question that will be about the quality on our web services. We have just been to Cannes where there is the international movie and TV distribution congregation and had a discussion with the Hollywood studios and how we will be distributing HD content on the web if we have a reliable DRM technology, so we will probably be moving to HD resolution and will have to up the bit rates

What are the requirements on bit rate from studios?

There is no requirement. I think the quality right now is actually not good but acceptable apparently. I mean the widget seems to suggest success where other people are willing to go with less optimal quality because it is easy and it is up there on the big screen and so on. I think at any rate it will have to be off the quality.

So we need to focus a little on how many Mbit HbbTV can support?

Yeah, I think that is probably very true. The other think I think HbbTV has installed for us especially thinking of the current Info channel recommendations saying this on in 15 minutes, you should watch this movie and so on. If customer have an HbbTV capable set and flips on to our Info channel clearly it should be interactive. I mean the whole recommendation guide mechanism can be expanded a lot once you have interactivity because you can say now you can individualize it, right now it is just saying everybody should movie in 15 minutes because we think it is cool. But once you actually have interactivity you can do any individual recommendation, so you could say or you can thumb up or down we won't show you again and so on and you can do a lot of algorithms.

Isn't this personalised recommendation you mean?

I mean we can do a lot of recommendations. I think HbbTV holds a lot of promises in that respect actually because I mean building an online store and letting people rent a movie is a big opportunity, but there might be other ways to do that. I mean there might be smart TV with widgets and there might be Xbox implementation, so you might buy an Apple TV style box. There might be a lot of different ways to do that, but may be renting a movie does not need to be completely integrated with the linear TV and so on. I think that the catch-up

service would be greater. I think DR they are thinking about this right when they launched, but we will see if this is the right decision.

But I think for us especially the whole interactivity and doing more about rich presentation of all our content, because we have the hmm for 10 years ago there were maybe 5 or 7 Danish channels and no body watched more than 3 of them and nowadays we have 20 or 20 something Danish channels and you have more that 50 channels all in all in your bug package, because of start over and catch-up and all these services you can chose. I mean the choices are multiplied massively and that's going to be even bigger and at least with our current TV archive and catch-up services I think the big problem is that we just treat it as a phone book where it is flipped to page one and then there is a lot of content so the whole presentation will be extremely boring.

TV is about people lean back and relax, so catch-up TV and other services gives you interactivity and control, you probably should expect that people take full control.

The penetration on the HbbTV, is that interesting for YouSee?

The time window for HbbTV

I think all depends on the coming couple of months because if the three leaning producers (Philips, Samsung and Sony are producing HbbTV really) manage into retail and they get all the sales people to inform about it I mean to stand around ad commerce it in a proper way. If DR makes a splash about it and soon the journalists write some good articles about the future of the HbbTV, then everyone will follow and no more TV sets will be produced without HbbTV within the 6-12 months or so.

With DVB-C no TV sets have had digital tuners until few years ago and then it came really fast it became an instant necessity.

Because DR launched something that you can actually demonstrate in the stores, in my opinion this is a good opportunity that will help HbbTV tremendously, even launching it as HbbTV test will help a lot.

How many of YouSee's customers will require one of those TV sets and every time they do, YouSee will have a potential buyer for the VOD

We know that between 400-500 thousand TVs are sold over the year and if we talk big figures let's assume 50% of our customers will buy it then so that makes 250 thousand piece and next year probably 80-90% will have HbbTV if things actually work out.

Roughly talking around 150000 of our customers using these sets will be actually working by the end of this year. However, that requires them to be online.

12.8.2   EBU email

Peter MacAvock:

1) How can aggregators/distributors benefit from HbbTV?
This is an interesting, but very relevant question. Aggregators form an important part of the broadcasting chain; they are sometimes referred to as Multiplex Operators. Whilst HbbTV is typically a set of services online, which are triggered from a broadcast signal, there is perceived benefit from the gathering together of some of the services to offer these across platforms. Taking the case of a terrestrial television multiplex operator, he has to gather

information from all of his content providers for the purposes of tuning and some basic EPG information. To extend this to the HbbTV signalling information is logical, and if there is an agreement between the different participants on a particular platform or multiplex, there is the possibility to arrange joint advertising deals (if allow), or even harmonise the offering of applications across content providers. Naturally, this depends on what the rules in a given market permit.

Concerning cable operators (other large content aggregators), there is a slightly different set of requirements since, in many cases, these people will also be offering their own services similar to broadcaster-centric services. Thus, ensuring that HbbTV services don't eat into their own offerings is important. Nonetheless, it is our experience that the cable sector is divided into two camps: one where the cable operator passes the signalling through their own networks, and thus allows the connected to link to HbbTV applications from the broadcasters; and the other, where the signalling is not passed through. Negotiations are still underway in many territories.

2) Can the red-button work without the signalling?

Yes. In cases where there is no HbbTV signalling, when the viewer pushes the red button, there are some TV sets which say "oh the user has just pushed the button, but I don't see any signalling to broadcaster data-services here, let me send the user to either my own manufacturer portal, or potentially to the website of the broadcaster.

12.8.3   IRT email

Klaus Merkel

- What is the HbbTV built-in browser?
It is an HTML/JavaScript browser of a specific profile adapted for TV sets.
You can find here
http://www.hbbtv.org/pages/about_hbbtv/specification.php
the links to the relevant specifications
- According to HbbTV specifications, RTSP is supported by HbbTV; How can we use it in HbbTV implementation, an example will be appreciated.
RTSP is only an option and I am not aware of any device, which supports RTSP. We do not use it in Germany any longer.
Current Live Streaming is based on top of http. Details can be found in the last chapter of the attached doc.
- Is it possible to use another adaptive streaming (apple hls, Google webM, Microsoft smooth streaming, adobe http dynamic streaming), beside DASH?
The HbbTV standard includes none of them. Maybe one or the other devices has implemented something different than DASH.
But HbbTV 1.5 includes only DASH.
- How do you keep aspect ratio of the HbbTV application on different TV sets?
The application plane is always 16:9 (1280 x 720) and it has to be aligned with "active video" of any 16:9 video.
We do not assume that HbbTV is used in letterbox mode on 4:3 tubes - technically this would be possible.

But applications have to obey the same safe area as video signals.

Micheal Probst:

- What is the HbbTV built-in browser?

HbbTV defines a browser profile based on CE-HTML. You should check the specification to check what is included. A starting point is the DAE reference guide

http://www.oipf.tv/docs/Release1/OIPF-T2-R1_DAE_Reference_Guide_v1_0-2010-03-11.pdf

HbbTV profiles the DAE browser, which profiles the CE-HTML browser.

- According to HbbTV specifications, RTSP is supported by HbbTV; how can we use it in HbbTV implementation, an example will be appreciated.

RTSP is an optional part of HbbTV, which is not implemented at any HbbTV terminal. For HbbTV 1.0 you will have to use HTTP progressive download.

- Is it possible to use another adaptive streaming (apple hls, Google webM, Microsoft smooth streaming, adobe http dynamic streaming), beside DASH?

Future HbbTV 1.5 terminals will support DASH (specific profile of DASH).

Other protocols are not supported by HbbTV.

- How do you keep aspect ratio of the HbbTV application on different TV sets?

The application shall be full-screen with a logical resolution of 1280x720, which is no problem on 16by9 TV sets. But I actually don't know if I got your question right?

12.8.4   Technical director Interview- YouSee

We have been even tried to implement applications on the TV manufacturer application systems with Widgets or App stores and so on; Its a bother because it is you have to agree with or every new model you have to adapt it; Its not for us, small operator like us .we have investigated possibility to implement an application part in CI model which contains smart card....It can be done, for us its a long way to go.

We are still on the way to set top boxes. We see, they will be smaller and smaller; they will change the application system to more; mechanism just like HbbTV with a browser in the set top box or in the TV and application server in the backend. That will be the route to go. The problem is that, we are still missing the standards for the TV set; In that sense, I am little bit optimistic about HbbTV. because we are really missing the standard way to deliver our services....

We feel, we are well prepared for HbbTV but on the other side, we are little bit mixed with because whether its implemented in chipset or not.

In fact we want to get rid of set-top boxes.

we have chosen Samsung TV; because it is a major TV brand in Denmark; so we have put effort putting our on demand services on the Samsung TV sets directly.

12.9 Group Contract

Team Co-operation Contract

1   Work Load

The primary load is scheduled to be equivalent to 25 ECTS and should be accomplished during Monday to Friday. The main part of the tasks of the project should be solved at the YouSee and must be initiated immediately in accordance to the Action Item List. Action Item List and a Time schedule must be established and maintained throughout the semester. Use of weekends may come into question in accordance to mutual agreement.

2   Evaluation of effort

Supervisor and coordinator meeting will be held when needed. The Action Item List is updated in accordance to the progress of the individual open items. New items are added when necessary. Sharing of the load is adjusted regularly.

3   Information Duty

In case of any delay in appointed meeting schedules, information must be forwarded to the other team member without unnecessary delay. Phones, SMS and e-mail may be used.

4   Atmosphere

All suggestions should be received and treated with an open mind. Criticism may be given in order to increase the efficiency of the team and is expected to be received in a constructive manner. In case of disagreement the team consults the supervisor/coordinator.

5   Meeting Efficiency

We will have a group meeting every Tuesday 9:30. Showing up in the group meetings is mandatory. Repeated absence with no valid (Sickness or force-major) reason may lead to exclusion.

All meetings in the team and with the supervisor/coordinator must be prepared to ensure efficient use of time. Before meetings with the supervisor/coordinator an agenda must be prepared not later than the day before the meeting.

6   Exclusion

In case of serious breach of this contract a team member may be excluded from the team. This can only come into action after warnings and a written notice. Exclusion requires unanimity in the rest of the team and must be confirmed by the supervisor.

In case of exclusion all documents, diagrams, programming codes etc. up to the date of exclusion, must be handed over to the group.

7   Evaluation of Contract

This contract may be subjected to changes at any time during the internship period. Changes are only valid in case of unanimity in the team.

12.10   Milestone plans

Application Development

ID	Milestone tasks	Start date	End date	Duration		mar 2012	apr 2012	maj 2012
1	**Milestone 1 (milestone plan)**	02-02-2012	07-02-2012	4d				
2	Group management	02-02-2012	02-02-2012	1d				
3	Info. About IRT Broadcast server	03-02-2012	07-02-2012	3d				
4	**Milestone 2 (Hello world)**	09-02-2012	27-02-2012	13d				
5	Understanding the system architecture	09-02-2012	13-02-2012	3d				
6	Installation & configuration	14-02-2012	14-02-2012	1d				
7	Understand the HbbTV TS.	15-02-2012	16-02-2012	2d				
8	Implementation	17-02-2012	23-02-2012	5d				
9	Test	24-02-2012	27-02-2012	2d				
10	**Milestone 3 (zaping between multiple services)**	28-02-2012	08-03-2012	8d				
11	Config services	28-02-2012	01-03-2012	3d				
12	Implementation	02-03-2012	06-03-2012	3d				
13	Test	07-03-2012	08-03-2012	2d				
14	**Milestone 4 (service development)**	09-03-2012	18-05-2012	51d				
15	setup	09-03-2012	18-05-2012	51d				
16	Implementaion	09-03-2012	18-05-2012	51d				
17	Test	09-03-2012	18-05-2012	51d				
18	**Milestone 5 (Report)**	02-02-2012	01-06-2012	87d				
19	Editting	04-06-2012	05-06-2012	2d				
20	Printing/CD burning	06-06-2012	07-06-2012	2d				
21	Report submission	08-06-2012	08-06-2012	1d				

Business Development

ID	Milestone tasks	Start date	End date	Duration		mar 2012	apr 2012	maj 2012
1	**Milestone 1 (milestone plan)**	02-02-2012	07-02-2012	4d				
2	Group management	02-02-2012	02-02-2012	1d				
3	Info. About IRT Broadcast server	03-02-2012	07-02-2012	3d				
4	**Milestone 2 (Services)**	09-02-2012	08-03-2012	21d				
5	Syudy different services	09-02-2012	16-02-2012	6d				
6	Case studies	16-02-2012	06-03-2012	14d				
7	**Milestone 3 (technology)**	09-03-2012	06-04-2012	21d				
8	Understanding the system architecture	09-03-2012	06-04-2012	21d				
9	**Milestone 4 (Market analysis)**	09-04-2012	07-05-2012	21d				
10	**Milestone 5(Report)**	02-02-2012	01-06-2012	87d				
11	Editting	04-06-2012	05-06-2012	2d				
12	Printing/CD burning	06-02-2012	07-02-2012	2d				
13	Report submission	08-06-2012	08-06-2012	1d				

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